

Viewpoint from a Protection against Erosion Project in Vietnam Coast

Quang Hung Nguyen, Hoang Hung Vu

Abstract: Ham Tien - Mui Ne coast 12 km long occupies 1/5 coastline of the Phan Thiet Bay, Binh Thuan Province. This place is considered to be the place with the landscape and development conditions of the tourism industry and is a place that provides many seafood specialties of Phan Thiet city. In the last decades of the twentieth century, this section of the coast was seriously eroded, with the average speed of sea going from 5 to 10 m / year adversely affecting the socio-economic activities in the region. So far, bank protection works have been working here for over 18 years. In early 2018, we conducted a survey, surveying, measuring and analyzing the current state of the structural systems of the embankments. Some results obtained from using the probability design model analyze the safety reliability of the embankment structural system to protect slope and the application of Multiple Criteria Analysis (MCA). The results have evaluated the safety reliability and advantages-disadvantages of each structural system. This paper presents the results of research on an effective summary of new structural applications and the advances of science and technology which has been applied to the project, the lessons gained from the implementation coastal protection projects Ham Tien - Mui Ne. The results are an important reference for current coastal protection research studies in Vietnam.

Keywords: Use Feasibility study, pilot projects, erosion protection, safety reliability, probabilistic design. Multiple Criteria Analysis (MCA)

I. INTRODUCTION

Ham Tien-Mui Ne coast (HTMN) is a concave part of the coast for 12 km , accounting for nearly one fifth coastline of Phan Thiet. On the banks of the alternate residential tourism services in the coconut plantation on the sand . Follow along the road connecting the city of Phan Thiet to Mui Ne . There where only the edge of the road edge 4-5 m . Chad to the west coast of Mui ne where fishermen's boat ramp . Every year the fishermen here about 10,000 new operators serve seafood processing and export demand . This place is considered where landscape and rank conditions for development of tourism there , and is where many special offers seafood of Phan Thiet . Paragraph coast HT - MN removal of sand dunes , sand erosion . In the 90s of the twentieth century , the rate of penetration of about 5-10 m / year have adversely affected the socio-economic activities in the region . Binh Thuan Province has implemented a number of measures to protect the coast against erosion but coastal erosion situation has not improved [1]

Since 1999 , the coastal protection project HTMN comply with the feasibility study of the Center of Science and Water

resource technology development, Water Resources University (WRU-FST-98). The feasibility study and the project has been implemented in the application of scientific and technological progress. Another highlight here is where the pilot project and complete the structural technology improvements . So far the project has been working here from 12-18 years . In early 2018 we conducted a survey research, survey, measurement and analysis of the current state of the shore erosion protection along with the results of the analysis of the process of information project implementation as well as the study analyzed the work of the new structure has been done here , but has learned lessons from this project. [2]



Fig. 1 Hamtien coast in 1998

II. BRIEF NATURAL CONDITIONS OF THE PROJECT

HT-MN coast is the rugged coast including parts and corrosion buildup . Approximately 85 % of the area 's natural sand dunes and high seasonal fluctuations . Unless some sections are rocky shoreline remains largely unconsolidated coarse sand or sandy soils prone to erosion .

The wind here changes seasonally . Winter winds are onshore wind East or Northeast, summer West or Southwest wind . Frequently, transfer season is in May and November . During these months the wind direction is unstable . Measurement results in Phan Thiet station , the average annual wind speed is 4.7 m / s , the largest average annual wind speed of 25 m/s , maximum wind speed in the frequency corresponding to 1 % of 28.3 m/s

Statistics in 1981 - 1997 average four year storm or a tropical depression hit the Binh Thuan . Duration of storm or tropical depression in October accounted for approximately 29.2 % , accounting for 38.3 % in November , December accounted for 16.6 %

The tides here transition from north daily to south half daily tide In the October , November and December often appear large tidal amplitude between 1.5 - 2m . Surge when a storm is about 2.2 m , and sprint is 0.7 m . Ocean wave heights (1%) from 2 to 2.5 m . Coastal currents are not affected by the river's mouth , mainly under the influence of waves and tides . Sediment here consists of unconsolidated coarse

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sand particles, particle diameter from 0.1 to 1.0 mm fraction has no clay. Sediment moving through the seasonal wind [1, 3]

III. MATH STUDIES ON HAMTIEN- MUINE COASTAL PROTECTION

A. Brief of WRU-FST-98

The project used the Typhoon model of Jexlianxki - 1965 - 1966 (TM - JL - 65-66) to determine the velocity field , storm surges , as a basis for assessing the current state of erosion, determine the standards and design criteria proposed shore protection measures for the coast of Mui Ne function . Fig. 2 is the flow velocity and the southwest wind surge.

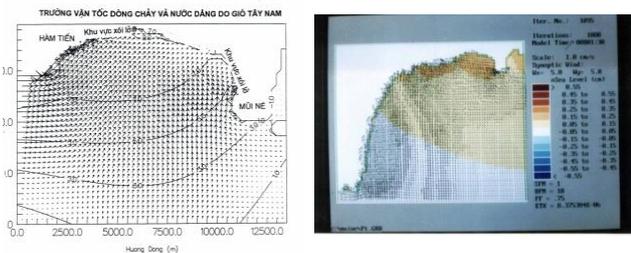


Fig. 2 Velocity field and the resulting flow surges

Results using TM - JL - 65 calculated with the data of storm named Tess Day landings Binh Thuan on 06/11/1988 , level 10 with wind speeds of 28 m / s for the largest value surges in regional HT - MN is 2.27 m and 0.74 m sprint .

Solve the hydrodynamic (HDMD) wrote to shallow waters by numerical methods has been a top speed of east flow when storm level 11 is 1.61 m / s, when storm level 12 is 1.79 m / s and north flow when storm level 11 is 0.46 m / s , when storm level 12 is 0.52 m/s .Calculations indicated when there is a storm , the impact of rising water and sprint coastal line has created quite a large operation in the range of 1-2 h .

Combining the analysis of the results calculated by the model TM-JL-65 and HDMD with the analysis of the current status of the survey data , terrain measurement survey , geology , meteorology and hydrology in regional studies have found changes in two regions of strong erosion . Here there is a coincidence between the analytical theory and practice , see Fig. 2.

Conclusion of the WRU – FST- 98 causes major cause of coastal erosion HT - MN is due to exogenous factors , prevailing winds and waves Southwest and Northeast rotate in years . When the weather like sudden thunderstorm , tropical cyclones and storm erosion is taking place here as powerful and complex .

The solution protects banks of WRU–FST-98 is: how to shore 200-300 m submerged bunding construction , designed for level 12 storm , waves on shore effects only occur when storms equivalent level 9-10. At the current stage erosion taking place building strong bank protection by embankment that is designed to work with storm levels 9-10 . The project was divided into two phases investment . Phase I, from 1999 - 2000 embankment construction of shore. Phase II from 2001-2010 submerged bunding construction WRU–FST-98 determined criteria for sub-projects bank protection as follows :[1, 3]

(1) To ensure stable conditions when working in the design conditions : tide level with frequency response is 20 % + 1.05 m , the lowest tide - 1,41 m , Storm height surge is 2.20 m,

sprint is 0.7 m , waves to calculate the wind speed 25 m/s ($h1\%=2.5\text{ m}$, $\lambda=3.5\text{ m}$, $\tau=5\text{ s}$)

- (2) Protect and defend the shore, the sand plain kept for tourism , create landscape environments , meet travel requirements and normal activities of fishermen in the area
- (3) The embankment flexibility , ease of ground deformation to maintain overall stability and local stability, material is resistant to sea water intrusion , convenient

B. The sub-project bank protection embankment has been done on the coast HT-MN

To combat shoreline erosion HT - MN urgently , before 1999 there were some erosion protection project has been built with many different types of structures , including traditional structural stones , the new structure TSC - 178 ... Here are a number of projects including the application of advanced scientific research and structural improvement of Vietnam .

(1) Project embankment from $K_8 + 405$ to $K_9 + 735$

This project designed by the Center of Science and Water resource technology deployment WRU, excuted by Binh Thuan during emergency erosion before 1999. (Fig. 3)

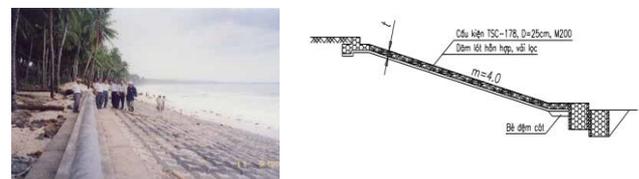


Fig. 3 KC-98 structural

Embankment in this project by assembling precast concrete friction associated structures with unit TSC - 178, (MLGBT-TSC-178) the toe is lined concrete pipe with stone in it , circular cross section , top wall 0.30 m high . (Fig. 4)

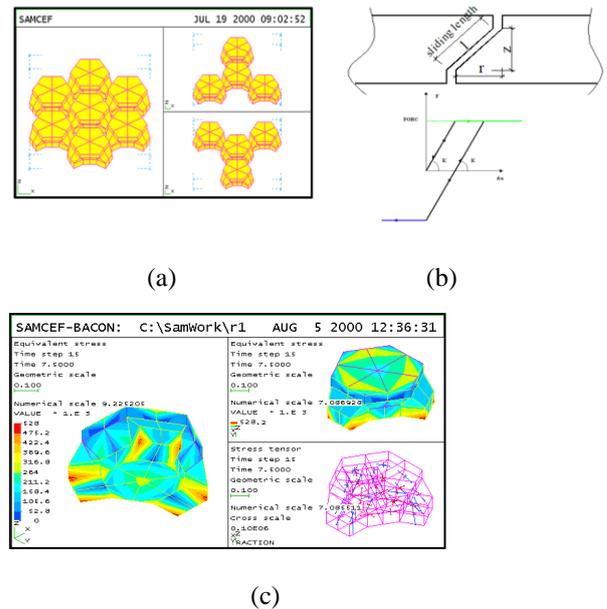


Fig. 4 TSC-178 Structures and structural diagrams calculated by software SAMCEF (a) structures TSC – 178 (b) diagram calculation (c) stress field of structures TSC – 178



Table 1. Maximum stress in unit TSC - 178

Storm level	σ_3 (N/m ²)	Settlement (mm)
IX (95 Kpa)	173 E3	122
XII (115 Kpa)	221 E3	176
Critical (360 Kpa)	550 E3	493

(2) The pilot project ANTIERO Vietnam – Belgium
The pilot - projects designed by Center of Science and Water resource technology deployment WRU, excuted by Binh Thuận (2001-2003) to protect the shore from K₉+860 to K₉+560. Embankment in this project by assembling precast concrete friction associated structures with unit type TSC - 178 but no improvement in the surface to reduce erosion (fig. 5) . Toe is lined concrete pipe has a hexagonal cross-section type of KC-HWRU- 2001 (Fig. 7) and (Fig. 8).

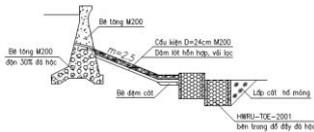


Fig. 5 ANTIERO Vietnam – Belgium structural

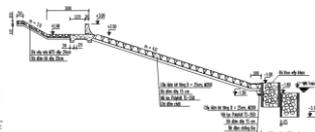


Fig. 6 Embankment structure excuted by Binh Thuan gornment

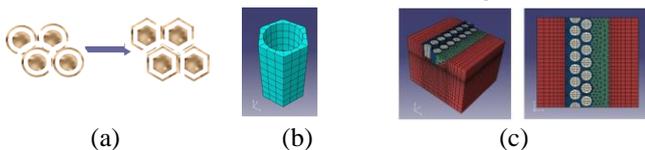


Fig. 7 Structural toe reinforced concrete pipe filled with rubble

- (a) Reinforced concrete pipe of circular cross section
- (b) Two reinforced concrete pipe cross-section hexagon, KC - HWRU - 2001
- (c) finite element mesh of Embankment toe

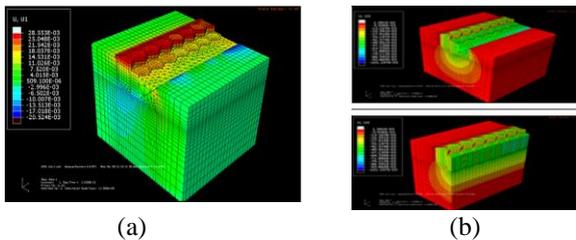


Fig. 8 Displacement field of Embankment toe by softwwave ABAQUS
(a) horizontal displacement ($u_x=20$ mm) (b) settlement of Embankment toe ($u_z=60$ mm)

- (3) bank protection embankment project K₁₂ +200 to K₁₄+200 .

This project designed and excuted by Binh Thuận gornment. Embankment in this project by assembling precast concrete friction associated structures with unit TSC - 178, (MLGBT-TSC-178) the toe is lined concrete pipe with stone in it , circular cross section. Fig. 6.

C. These scientific advances and technological innovations have been applied to the project

(1) The calculation application TM-JL-65-66 results by Asso. Prof Dr Nguyen Van Lai consistent with observed data and simulated erosion area is relatively consistent with erosion events have been taking place off the coast of HT - MN . This is the theoretical basis and practical to make scientific arguments put forward measures to protect the banks of a reasonable and feasible . [3]

(2) The application of advanced mathematical models structural analysis

In science and technology projects bilaterally Vietnam - Belgium , Belgium is the Chairman Prof. Dr. Dang Hung Nguyen , University of Liege . Chairman of the Vietnam Prof. Dr. Van Mao Nguyen WRU. The structure was put to the test in the ANTIERO project embankment has improved , a top bunding, slope crest was lowered , and sand back to the beach . The face of the unit type TSC - 178 have been removed to reduce the level of concrete erosion .

Combining training , scientific research and serve as a producer of outstanding content ANTI ERO project . Higher education program in Vietnam Belgium (MCMC) has many research and development models charged to the structural analysis MLGBT-TSC-178 a new structural improvements in Vietnam . The student MCMC Methods used finite element calculation methods for MLGBT on nonlinear elastic model in software SAMCEF - MECANO has to result in destructive structural changes MLGBT-TSC-178 relatively consistent with the results of experiments in the wave flume and MLGBT-TSC-178 experimental model similar mechanical deformation of solid objects . The results of the calculations with the boundary conditions are different but as a general comment MLGBT-TSC-178 sustainable structures and can reduce the thickness of the structures .

Refer to the results of the MCMC analysis of the structure , the project design ANTIERO has decided , as unit in MLGBT-TSC-178 is reduced but did not need extra dimension section thickness to compensate for this weight . [4- 6]

(3) Embankment in the three sub- projects are used with components MLGBT style TSC - 178 . TSC - 178 structures are patentable inventions (Fig. 6), the patent owner is Dr. Phan Đức Tac. The results of the project completion technology , theoretical studies , experiments in laboratory wave flume of the Water Resources Institut (1998) , destructive testing mechanism in laboratory solids deform of WRU (1998) and the structural analysis of the MCMC program showed that MLGBT-TSC-178 is flexible structures have high stability , convenient for maintenance . [7, 8]

(4) Using the KC - toe style HWRU -2001
KC - toe style HWRU - 2001 as shown in Fig. 3b is the product of scientific research ministry , Prof. Dr. Nguyen Van Mao as chairman . Using reinforced concrete pipe has a hexagonal cross section replaces the round section pipe , has increased the area of contact between the pipes , the friction increases , permeability lasted contours , restrictions sand dragged from the slopes due to wave and seepage . (Fig. 7).

The results of experiments in laboratory wave flume synthetic hydraulic WRU (2006) and the used finite element method in ABAQUS (2012) (Fig. 8) results of Prof. Dr. Huy Phan Tan . Dang Hung Nguyen, HungViet Technology Company, showed that KC - HWRU - 2001 is a flexible structure toe, have high durability. [6, 9]

D. Research the current state of the embankment structure

In early 2018, a group of high school students of Thuyloi university has taken the survey , measuring structural assessment of the status of the sub-projects and



evaluate the effectiveness of the HTMN coastal bank protection projects

(1) The collection , investigation and measurements carried out in the field reading

- Collect data on wind , storms , waves and tides have been occurring in the project
- Investigate the situation of erosion and sedimentation occurred after the first phase of the NC - WRU – 98. (Fig. 9).
- Survey measurement of displacement , the concrete strength , the level of sea water corrosion , erosion by waves for structural concrete embankment shore . (Fig. 10).



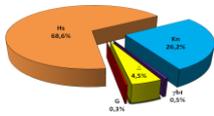
Fig 9. Effectively creating mudflats by ANTIERO project



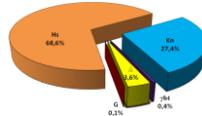
Fig 10. Survey measurement of displacement , the concrete strength

(2) The calculation and analysis

- Data collection , surveys , measurements at the project were analyzed according to the statistical probability calculation serves for reliability structural safety embankment.
- Using the critical method and the theoretical reliability method to evaluate the work of the existing embankment .
- Based on the main objectives of the project and the survey results as well as the calculated results , the researchers have developed specific criteria to meet the requirements of MCA methods used in classification projects . (Fig. 11)



(a) WRU project KC-98 structural



(b) ANTIERO Vietnam-Belgium structural

Fig 11. Influence of random variables on the probability of occurrence of the mechanism of embankment structural instability

(3) The conclusion of the current state of research

- According to the survey results in the period from 1999 to now , the structure of the embankment in the basic project here is not to work with conditions exceed design criteria .
- Currently only HTMN coast implementing Phase I, Phase II unrealized 's NC-98- WRU
- The safety factor as well as the reliability safety of TSC - 178 components as well as structural improvements from TSC - 178 type still satisfying working conditions . The degree of loss of strength in concrete structures are not significant , but the level of seawater corrosion and erosion by waves , especially at the edges against the surface waves are relatively distinct components
- The pilot project ANTIERO Vietnam - Belgium lowered crest of the slope , gave way to the beach and sand created to meet the requirements of the project objectives . The analytical results MCA , this project is also to meet project goals much more detailed than the other two sub-projects
- The project was implemented in accordance with the basic construction , however maintenance work has not been regularly.

IV. THE LESSONS FROM HTMN COASTAL PROTECTION PROJECTS

- (1) The sub- projects in HTMN coastal protection projects achieved goals against erosion due process was performed in compliance with the overall study WRU - NC - 98 . Among them were ANTIERO projects use the analysis results by an erosion rule reasonably should have achieved the second objective is embellished environmental landscape and create sand for tourism .
- (2) HTMN shore protection project , the focus of many experimental projects should have applied the results of scientific and technological progress and abroad . These applications make clear here is not only the quality of works is increased which it had a positive impact on the design , construction , construction management palm coast guard .
- (3) The project was created for the students of the MCMC and WRU perform scientific research linked the actual project not only creates good conditions for students that have an impact positive improvements in structural construction projects as well as in the operation and maintenance works .
- (4) Structural toe KC - HWRU - 2001 was first in practical applications and it has been through the experience ANTIERO project . Lessons learned about as well as the actual construction work of this structure here was convincing the user . So many projects currently in Nam Dinh , Ninh Thuan , Binh Thuan has effectively applied this structure .
- (5) There exists in the current HTMN project is : two verses from the K_{8+735} to K_{9+405} and section K_{12+200} to K_{14+200} . has chosen slope crest level is too high , pitched roof covered with concrete structures to take up most of the area of sandy sediment offensive to the natural landscape and environmental tourism . This can be seen as flawed lesson of the project.

V. CONCLUSIONS

The study results summarize the implementation process as well as the current state of the structure at the HTMN coastal protection projects has learned some lessons. The lessons learned about compliance with the overall results of the study , the application of scientific and technological advances , convincing people to use the new structure , combined with practical training are drawn from HTMN coastal protection projects is a useful reference for the implementation of similar projects in Vietnam today. Further research will be conducted to assess the changes in the shoreline after the protection works are in place so that there will be optimal solutions to improve the roof protection structure for the whole HT-MN coastline.

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AUTHORS PROFILE



Quang Hung Nguyen was born in 1975 in Hanoi, Viet Nam. He received the Engineering's degree and M.S. degrees in hydraulic construction from the Thuyloi University of Vietnam, in 1997 and 2000 and the PhD. degree in hydraulic structure from Wuhan University, China. Since 1998, he is a lecture in Faculty of Civil Engineering, Thuyloi University and becomes Associate Professor since 2009. From 2007 to 2013, he was Deputy Director of the Institute of Civil Engineering, designed and built many key projects of Vietnam. He is also principal investigator and member of many national science projects as well as Vietnam Ministry of Agriculture and Rural Development. Since 2013, he has been a senior expert in hydraulic construction of Vietnam Ministry of Construction. He is the Advisor of more than 200 bachelors, 40 masters, 2 PhD specialized in hydraulic construction.



Hoang Hung Vu was born in 1978 in Hanoi, graduated from Thuy Loi University, received a Doctorate in Marine Structure Engineering from Hohai University - China, Associate Professor of Thuy Loi University. He teaches hydraulic structures, chairs and participates in many scientific research projects at all levels, verifies many large hydropower projects. Main areas of research are simulation of structure and safety of large concrete dam structures, earthquakes and heat effects on water works, large span valve gates