Government of the Socialist Republic of Vietnam
Ministry of Agriculture and Rural Development

Government of The Netherlands
Ministry of Transport, Public Works and Water Management

SEA DIKES NORTHERN PART OF VIET NAM
(Red River Delta)

- Review -

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EXECUTIVE SUMMARY

Problem definition

The coastal areas of Vietnam are repeatedly hit by devastating storms and typhoons. Protective sea dikes are overtopped or breached frequently, with the resulting flooding causing damage to agriculture land, loss of life and crops, and destruction of infrastructure.
In the coastal area of the five northern provinces of the Red River Delta, 361 kilometres dikes will be upgraded, assisted by the World Food Program, project number 5325. This project is the follow-up of the WFP project number 4617, which was focused on 7 provinces along the Central Coast.

Scope of the mission

As a result of the strong similarity in physical nature between the Netherlands and Viet Nam on water related issues, the Ministry of Agriculture and Rural Development of the Socialist Republic of Vietnam has requested to the Ministry of Transport, Public Works and Water Management of the Netherlands for technical assistance on flood control issues.
As a first step the Dutch Ministry has sent in November 1995 two representatives, mr. Anne van Urk and mr. Ale van der Hoek, to discuss many flood control and water management issues in Viet Nam, on which cooperation can take place. One of the issues with the highest priority was to get a second opinion on the sea dike designs as to be used in the WFP program.
So as a second step in the program a mission visited Vietnam, from 26 March to 12 April 1996, in order to evaluate the existing designs and execution options for the five coastal provinces of the Red River Delta (RRD).

Design methodology

In order to decide what kind of protective measures should be taken in case of coastal defence problems, different preceding activities must be realized. On the one hand the causes and the extent of the coastal problem should be assessed by means of a study into the boundary conditions and the morphological processes in the area considered. On the other hand an evaluation should be made of the different interests, which may be related to safety, agriculture, environment, economy, etc.

There is a large research potential available in Viet Nam, e.g. Department for Dike Management and Flood Control, Vietnam Institute for Water Resources Research, Marine Hydrometeorological Centre of the Hydrometeorological Service, and Hanoi Water Resources University. However, in order to use this potential effectively in solving of practical coastal problems a more close cooperation between the different parties in the design process should be further stimulated. To achieve this goal some administrative actions should be undertaken by the Ministry of Agriculture and Rural Development.

It should also be considered to develop different possible solutions to a problem and compare these solutions on basis of the interests involved. Even future development on economy and boundary conditions should be considered. Then, the available money and labour can be used in a (more) efficient way. Therefore a so called 'policy analyses study' should be prepared, on province-, district- or project level.

To improve understanding between various institutes and in order to involve the different interests in the design process, the activities related to a certain program (problem or project) should be organized in a form of multidisciplinary project teams and giving proper responsibilities to the project-leader.

Risk level

For a proper design, as a starting point, an acceptable risk level has to be fixed. The present designs for the rehabilitation and upgrading of the sea dikes in the Red River Delta are based on design-circumstances which will occur with a frequency of 5 % each year (= 1/20 years). However, the interests to protect vary for the different area. In order to get a balance between the investments for dike improvement and the value of the interests to be protect, it is advised in the future to consider a differentiation in risk level.

From the moment that people realize that the area they inhabit, is protected in a sufficient way, investments will be done. Moreover, the living standard and the economic situation in Vietnam will expand in near future.

Consequently the interests in the area adjacent to the sea will increase and in order to keep the interests and the safety level in the future in balance, the safety level will most probably be upgraded again. Therefore it should be considered to allocate a free strip on the landside of the dike for future improvements.

Natural boundary conditions

Topography and morphology

For a sound planning and design of sea defences it is necessary to know the bottom topography in front of the coast (at least in the zone from 'deep water' to the toe of the dike) and even to make a prediction of the shoreline development for the lifetime of the structure. Such a prediction can be made based on the historical coastline development in combination with a morphological analyses of the coast. In such an analyses the effects of the sediment load of the rivers, longshore and cross shore sediment transports etc are evaluated. Based on the shoreline prediction the design conditions of the sea defence can be determined. Further, decisions can be made to concentrate efforts and investments on for instance eroding shoreline sections.

Waves

Since the bigger part of the coastline of the northern part of Vietnam has a shallow foreshore, in most cases the design wave heights for the sea defences will be depth limited. Based on the present bathymetry and on the predictions for the near future the design wave height for the sea defence design can be calculated. However, it is still important to know the deep water wave climate (wave height, wave period, frequency distribution). Not only for the sea dike design but also for other purposes (morphology).

A reliable deep water wave climate can only be obtained by long term measurements. In this way a reliable set of statistical wave parameters can be defined. This data set should include directional frequency distributions of the wave height and wave period.

Design water level

The design water level is a *dominant* parameter in design of the crest height of the dike. Therefore much attention should be paid to the proper quality of prediction of the design water level and its components: astronomic high tide and storm surge (= wind set-up). Than it is possible to tune the design water level to the acceptable risk level.

Comparing the various sources of information it might be possible that the tidal level which is used in the present calculations already includes the wind set-up. It appears that this value has been derived from a water level exceedance curve and not from the astronomical tide-table figures.

It is recommended to verify and validate the wind set-up formulation. This can be done by comparison of water level measurements and wind set-up computations.

Conclusions and recommendations
The proper quality of input data/hydraulic and geotechnical boundary conditions is of a primary importance for a proper design. An expert working group should prepare a document with boundary conditions for the coast of Viet Nam, which should be used as a basic document for the design process.
With respect to boundary conditions for sea dike design it is recommended to:

- analyze all the relevant available wind, wave, current, water level and bathymetric measurements in order to define the boundary conditions along the entire coast the best as possible. Priority should be given to the water level analysis (required to obtain the design water level) and the bottom topography (required to obtain design wave heights);
- prepare boundary condition guidelines and submit these to the local (provincial) governments. These standards will contain specific values (based on the analyses of measurements) to be applied or standardized procedures to calculate certain design parameters;
- determine priorities for improvement. For example: setting up a long term wave measurement campaign.

Design

Crest height
The subsoil along the line of the dikes to be improved will vary. So the heightening for the dike improvement will be different. Therefore it is recommended, especially in areas with bad soil conditions or with settlement problems, to calculate the expected settlement of the subsoil which will occur due to load of earthfill. If sufficient data are available, it should be supported by geotechnical calculations.

The runup on the dike will be strongly influenced by the slope angle and the roughness and permeability of a revetment. In the present designs there is no distinction for the various types of revetment.

In cases that the runup is calculated for an exceedance of more than 2%, also overtopping of the dike should be calculated including its consequences for the stability of crest and inner slope.

Due to the above mentioned aspects it is recommended to examine the present calculations for the crest height of the dike in according to state-of-the-art design standards, and differentiated for the different dike sections.

Revetments
In the present designs of sea dikes Russian formulas as well as the Hudson formula (USA) are used. All these formulas are originally developed for riprap and/or rubble mound structures (breakwaters), which are based on the weight of elements. However, these formulas have also been applied in the present designs for calculation of thickness of pitched stone and block revetments. The design of block revetments should be based on the thickness of a block and not on the weight of a block.

In general, for new dikes where settlements can be expected, the loose protective units (stone, placed blocks) are preferred instead of interlock blocks, because of there flexibility and re-use possibility after eventual damage.

The existing riprap on various dikes, which is not stable enough for design conditions can still be applied in the zones of less wave attack (e.g. above design water level + ½ H_s, and at the toe structure). The toe structure should be strong enough to resist the sliding forces provided by the slope revetment. In all cases proper transitions from the slope protection into the toe protection, and into the crest, are very essential for the stability of the revetment.

As **conclusion**, the actual design approach concerning the stability of the revetments on the sea dikes is not always based on the right formula and is also inconsistent, and can not be accepted as a final design. Also the construction of the transitions should be re-considered.

Foundation
Special attention should be paid to geotechnical aspects of dike design, such as foundation on soft soils, and problems of compaction of clay-earthfill especially during dry and warm periods when the clay is becoming very hard. An important question is "what is the influence of possible cavities between the blocks of clay inside the dike body on the geotechnical stability of the dike?"

Design standards
The actual design standards for coastal protection (including dikes) in Viet Nam should be updated according the actual state-of-the-art of the international knowledge in this field. Therefore new design guidelines should be formulated including the selection of proper design formulas for various revetment types, including stability of sublayers and subsoil, and also including design recommendations concerning toe protection and transitions.

Implementation of knowledge
The existing knowledge on design, construction and maintenance of dikes, especially at districts, needs upgrading. Because of a language problem, the access to the current literature is limited. Therefore training of technical staff is urgently needed.
To improve communication in the field of transfer of know-how from The Netherlands to Viet Nam, the one-year training of at least two young engineers at the International Hydraulic Institute (IHE) in Delft, supplemented by about two months orientation within the specialistic Rijkswaterstaat Divisions is considered as a minimum. It is stressed that for a training in the Netherlands an adequate knowledge of the English language is necessary.
Moreover a short course in Viet Nam for the engineers involved the project should be considered. For the long term it would be important that the (backgrounds of the) standards will be teached at the University.

Seminar
On a seminar on 9th April, attended by representatives of DDMFC, provincial and district design engineers, Hydraulic Institute, Hanoi Water Resources University and Meteorological Service Viet Nam, the Dutch mission has presented the results of the mission. Also a case study was presented on the calculation of crest height and the stability of revetments, based on the state-of-the-art design standards.

Execution
In order to have a reference to check, the detailed specifications of the design and execution and permitted tolerances, should be established in 'execution specifications' and proper drawings. To achieve a proper construction special attention should be paid to the execution of the revetment, the transitions and the compaction of the earthfill.
Surveillance during the execution by a supervisor who is familiar with the design of the structure, and a proper quality control system, are essential for a proper final result of a project.

Operation and maintenance
There should be a clear definition of responsibilities of various management levels resulting in 'short lines' in respect to decision and necessary actions concerning the repair of damages after the storm.

After each storm an inspection report should be prepared. Small damages should be directly repaired by the local authorities and people.
The storm damages should be repaired before the next storm season starts. The unrepaired locations (even with small damages) may lead to the serious damages during the next storm season, which can be very costly to repair.
A check list for post-storm inspection and reporting should be prepared by the Department for Dike Management and Flood Control, as well as the maintenance guidelines and definition of responsibilities.

During the lifetime of the structure the boundary conditions (e.g. due to the morphological changes) and also the strength of the structure can change. Therefore it is recommended to order the local authorities to report periodically the actual state of the dike in respect to fulfilling its defence function.
For realization of this goal it is needed to have a sufficient data base. In the present situation this actions are basically taken place.

General conclusions
From the observations of the mission and the comments as drawn in this report, the following general conclusions can be mentioned:

- In all reviewed designs, each province has used different prediction methods for waves and wave runup, and stability of the revetments. Because of that it is nearly impossible to compare all these designs.
- The applied design water level seems to be too high; on the other hand the calculated wave runup is insufficient. As a preliminary conclusion it can be mentioned that the calculated crest height is sufficient in Nam Ha Province and at some stretches in the other provinces. At most stretches the crest height seems to be insufficient. For a better judgement detailed calculations are inescapable.
- The wave prediction, especially for long and shallow foreshore, and its interaction with dike slope is insufficient. This will have repercussions for the calculated runup and revetment stability. Some prototype measurements on local wave spectrum and interaction with existing dikes, and laboratory investigations of runup with shallow foreshore are recommended.
- The actual design approach concerning the stability of the revetments on the sea dikes is not always based on the right formula and is also inconsistent, and can not be accepted as a final design.
- In most cases the dikes to be improved have a various exposition in relation to the dominant wind direction. From the designs it can be concluded that in each province only one direction is considered.
- Special attention should be paid to the compaction of clay-earthfill
- Feasibility study incl. costs should be done on stability of revetments at lower design frequency of water levels and resulting waves (e.g. 1/50 and 1/100 years). Mostly it is possible to achieve much higher stability of revetments at a little additional cost. It will reduce the amount of future repair costs and will allow additional heightening of dikes without necessity of placement of new revetments.

Preliminary Action Plan
The Dutch mission, based on her observations and conclusions as drawn above, is recommending to undertake the following actions:

Dike program 1996-1997
The designs of dike stretches planned for rehabilitation in 1996 and 1997 should be examined again, as soon as possible (without waiting till the future design guidelines are prepared). The Dutch technical documents [6] and [7], which are provided to the DDMFC, can be of use for this examination. In order to prevent a delay in the WFP-program it is recommended to consider a second opinion of the adapted

designs by the members of the Dutch mission, in the foreseeable future. For this purpose it is necessary to provide the basic data of the dike stretches for realisation in the near future.
The proper quality of input data/hydraulic and geotechnical boundary conditions is of a primary importance for a proper design. An expert working group should prepare a document with boundary conditions for the coast of Viet Nam, which should be used as a basic document for the design process.
It is recommended to organize a semi-permanent help-desk at the Rijkswaterstaat for occurrent technical assistance during realization of this program.

Design guidelines
Project definition and project proposals should be worked-out concerning the preparation of the national design guidelines for sea dikes in the coming two years (1997-1998). For the transfer of the available Dutch know-how on this matter, the appointment of the joint working-team (Viet Nam - The Netherlands) is recommended.
To ensure the effectiveness of such working group, the project should be commissioned by, and realized under direct responsibility of the Vice-Minister of the Ministry of Agriculture and Rural Development. The project-team should consist of representatives of DDMFC, one or two designers from the provinces, representatives from the Hanoi Water Resources University, Institute for Water Resources Research and Meteorological Service. There must be a proper commitment of all these parties to the project and the existing boundaries between various departments should disappear.

Educational program
Parallel with the activities as mentioned above, the short- and long term educational program for technical staff should start.
It should include the following components (steps):
- short course (2 to 3 weeks), for design staff in Viet Nam, preferably in 1996;
- short visit of Vietnamese designers to The Netherlands;
- training of few (young) engineers in The Netherlands, by attending the yearly course at the International Hydraulic Institute in Delft, and including a 1 or 2 months period of orientation within the Rijkswaterstaat Divisions;
- upgrading the teaching program of the Hanoi Water Resources University.

Integrated studies
Feasibility (integrated) studies should be undertaken, concerning the coastal area of Nam Ha Province, with special attention to the erosion problems of the Hai Hau district.
Besides the studies on the physical components, an integrated policy analysis for the coastal area of Nam Ha Province should be prepared (safety/risk analysis, evaluation of local interests, additional coastal protection measures, environmental aspects, etc.). The results of this policy analysis will provide the base for the necessary decisions concerning this area, by the policy-makers.