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Effects of Level Inundation on Top of Spur Dike to Project Efficiency of River Trainning- Apply for Red River Delta

Kien Quyet Nguyen, Quang Hung Nguyen

Abstract*: The spur dikes project is a type of work that affects the flow, built quite early in Vietnam, especially on the Red River system. Although there are many spur construction projects, it has been effective in preventing river bank erosion and stabilizing the flow of ships to serve water transport. However, there are also clusters that are not effective, one of the reasons is due to the low elevation of the spur dikes. The content of the author's analysis influences the level of flooding on the top of the spur dikes to the effectiveness of the river correction project, thereby proposing a reasonable height of the spur dikes to enhance the capacity of adjusting the river by mine construction works. spur dikes in Vietnam.

Keywords*: Spur dikes construction works, submerged spur dikes, erosion, spur space arrangement.

I. INTRODUCTION

Construction works impact on the flow: Construction works showing the advantages of people to conquer nature are the types of construction works affecting the flow, the most positive element of the river. This type of construction is most commonly used as a spur dikes, then a longitudinal dike, a lock, or a river cut. Spur dikes construction has been built more and more on rivers in the Red River Delta because it can meet the effectiveness in preventing river bank erosion and stabilizing the flow of ships to serve waterway traffic. However, there are also clusters that are not yet efficient, but one of the reasons is due to the low elevation of the spur dikes. The content of the author's analysis influences the level of flooding on the top of the spur dikes to the effectiveness of the river correction project, thereby proposing a reasonable height of the spur dikes to enhance the capacity of adjusting the river by mine construction works spur dikes in Vietnam.

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Figure 1. Spur dikes project on the Red rive

II. BASIS OF SCIENCE AND METHODOLOGY

A. Flooding level, not flooding conception of spur dikes construction, [2], [4]

Non-submerged spur dikes construction works: construction works with elevation without being flooded at the water levels in the dry season, middle water season and flood season, meaning the ratio H/D = 1 (H depth of water level in the construction area correspond to flood water level, D height of correction process.

Submerged spur dikes project: It is a project with an elevation equal to the water level in the middle season and flooded by flood water, meaning the ratio 1 <H/D <1.5.

Underground spur dikes construction works (deep flooded): construction works with elevation equal to the water level but flooded in the middle water season and flood season, which means the ratio H/D> 1.5.

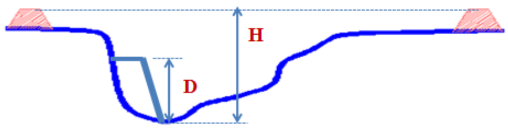


Figure 2. Cross section of the river bed area with spur dikes project

B. Basis for evaluating the technical efficiency of spur dikes mines, [3-6], [10]

The technical efficiency of the spur construction is assessed through the safety of the protected shoreline and the structural stability of the spur dikes itself. The safety of the protected shoreline is ensured through the size of the water area that the spur creates, in which the length is the dominant role. The larger the water area size, the higher the protection effect of the shore. The stability of the spur dikes itself depends on the size of the local erosion of the spur tip, in which the depth plays an important role. The depth of erosion is directly determined by the flow velocity (or indirectly the flow structure) of the tip of the torch, in other words the difference between the flow velocity and the flow velocity of the sludge lead the torch.

C. Methodology

In order to achieve the research objectives, a number of the following research methods will be used: the method of adjusting and analyzing real measured data; Research methods based on physical models

1) Methods of analyzing real data

Analysis of measured data was carried out based on data collected for many years (topography, geology, hydrology, sediment, remote sensing images and construction design files) from various sources, corrected and processed to ensure the necessary reliability.

2) Research methods on physical models, [1], [4-7], [9-10]

The physical model of the Red River passing through Hanoi is designed with a scale of 1/400 and a standing ratio of 1/100, satisfying the same rules of Froude, Reynolds and resistance.

- Similar to Froude: $$\frac{\lambda_v^2}{\lambda_h} = 1 \quad (1)$$

- Similar resistance: $$\frac{\lambda_V^2 \lambda_n^2 \lambda_l}{\lambda_h^{7/3}} = 1 \quad (2)$$

- Law of continuity: $$\frac{\lambda_Q}{\lambda_l \lambda_h \lambda_v} = 1 \quad (3)$$

- Automated similarity: $$\frac{\lambda_t \lambda_v}{\lambda_l} = 1 \quad (4)$$

Strictly calibrated and tested models ensure the reliability of research results. The water level measuring device is the water level gauge, on the measuring needle divided to the smallest unit of 1 mm. On the chain, it can read up to (1/10) the smallest unit of the gauge and is 0.1 mm; The flow meter is the Pelf's Dutch speedometer PEMS.

The dynamic field is studied with the flow level: The maximum flood flow Q = 24,166 m3 / s (Dyke design flood).

- Researching the hydraulic regime in the condition of the current situation and the layout conditions of the construction solutions. The main physical phenomenon to be studied: velocity distribution field.

- The experimental model field is shown in Figure 3.

Figure 3. Plan of physical model

III. EFFECTS OF LEVEL INUNDATION ON TOP OF SPUR DIKE TO PROJECT EFFICIENCY OF RIVER TREATMENT

A. Current status of some spur dikes cluster projects in the Red River Delta

After the construction of the spur project, the phenomenon of local erosion of the tip of the spur dikes will of course occur, but the space of the river bed between the common spur dikes is deposited to create effective protection of the bank as the target of construction. construction and working principle of spur dikes. the phenomenon of erosion in space between spur dikes in the system, even deepening into the shore and root of the work, causing bad consequences of instability of the project. The factors that cause unusual developments in the spur dikes system are mainly the layout of the system of construction works such as: the distance between the spur dikes; spur dikes length; the angle between the spur and the flow direction; top elevation of spur dikes. In the content of this article, the author deeply analyzes the influence of flooding level on the top of the spur (elevation of the spur dikes).

Elevation of the top of the spur: Most of the spur construction projects built on rivers in the area of the Red river delta have elevation higher than the water level to adjust the middle water season, while the instructions are higher than the middle water level. (0.5÷1.0) m. The top elevation of some spur dikes of the spur dikes has been built in the Red rivers delta, which are listed in Table 1, and it is found in the table that the elevation of the spur dikes peak is lower than the water level corresponding to the flow generated, In the case of flood flow, the spur is deep from (5÷7) m, even the cluster of spur dikes at the range, Phu Gia, and four quarters is deeply submerged from (7÷8) m. therefore, the time for spur dikes to be flooded is relatively long as the cause of eroding holes in the downstream of the spur dikes (Figure 4).

Table 1. Peak elevation of some spur dikes cluster in Red River delta [2], [4], [8]

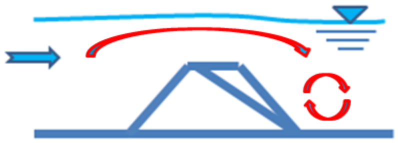
TT	Name of work	Elevation of spur dikes	Water level	Flood water level	Notes
1	Co Do	+10.5 ÷ +12.5	+15.0	+17.5	Red River
2	Le Tinh	+11.8 ÷ +12.5	+15.0	+17.5	Red River
3	Tam Xa	+7.0	+10.0	+13.4	Red River
4	Phu Gia –Tu Lien	+5.0 ÷ +6.0	+10.0	+13.4	Red River
5	Yen Ninh	+4.5 ÷ +6.0	+6.03	+8.25	Red River
6	Nguyen Ly	+4.5 ÷ +6.0	+6.03	+8.25	Red River
7	Chương Xa	+4.5	+6.03	+8.25	Red River
8	Vo Vang	+4.5	+8.5	+10.0	Duong River

Figure 4. Spur dikes system on Duong River

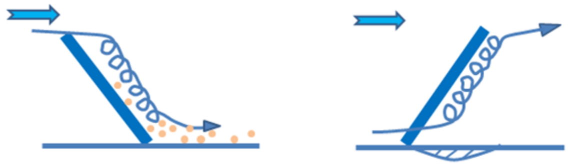
Characteristics of spur dikes work in submerged conditions as follows:

- When the water spills over the top of the spur dikes, the vortex is in the middle of the spur;

- Along the downstream slope of the spur, there is a horizontal vortex with horizontal axis, facing from the mine to the shore if arranged upstream, from the shore to the top of the spur dikes field if downstream. The result is an eroding hole downstream of the spur, figure 5, 6,7.

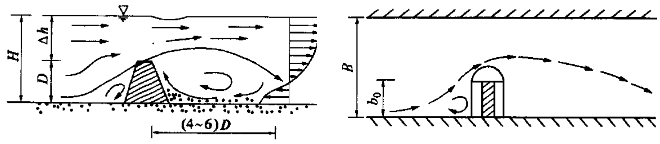


a) horizontal vortex flow after submerged spur dike



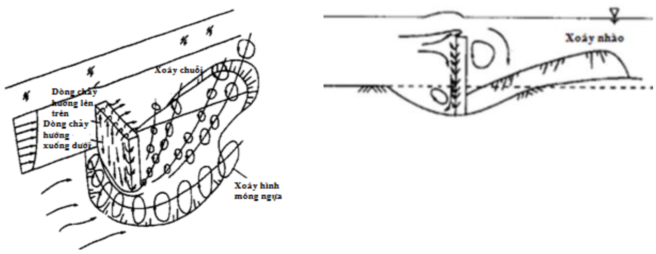
b) submerged spur dike is arranged in inverse causing sedimentation *c) submerged spur dike is arranged downstream causing shore erosion*

Figure 5. Mechanism of flooded spur dikes work



a) Vertical section *b) Cross section*

Figure 6. Downstream whirlpool of submerged spur dikes



a) *b)*

Figure 7. Whirlpool system of submerged spur dike

B. The relationship between the spur dikes top flow and the height of the spur dikes project

Research results of scientists around the world indicated that [2], after arranging spur dikes into open channels, the factors affecting the flow through the top of the spur dikes have: depth (H) at location, height of spur dikes (D), depth of spur dikes (H - D), river width (B), torch length (b0), roughness coefficient (n), slope water surface (Js), river bottom slope (Jb), flow (Q) and number (Fr), etc. The flow through the groove peak (Q_0) is expressed as the following formula:

$$\frac{Q_0}{Q} = \left(\frac{b_0}{B}\right)^{\eta_1}\left(\frac{H-D}{H}\right)^{\eta_2} \tag{5}$$

Where η_1, η_2 are experimental parameters

To determine the empirical coefficients η_1, η_2 the author conducted experiments on physical models of the working of spur dikes at the section of Tam Xa Red River, the study scenario is as follows:

- Constant experimental flow: Design flood Q = 24.166 m^3/s;
- Length of spur dikes (b0) unchanged, b_0 = 160m;
- The width of the riverbed (B) remains unchanged, B = 2620m;
- Elevation of river bed in the area where spur dikes (-2.0) is placed;
- Water level corresponding to flood flow level, H = + 13.4;
- Elevation of the spur dikes peak starts (+5.0);
- Depth of water level at the work position remains constant (H); H = 15.4m;
- The height of the spur dikes changes (D), starting D = 7m then gradually increases with ΔD = 0.5m;

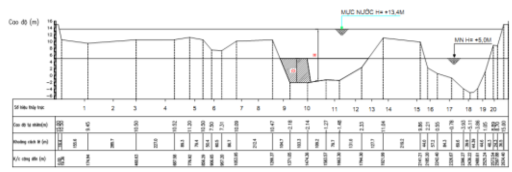


Figure 8. The section of the river bed with spur dikes arranged

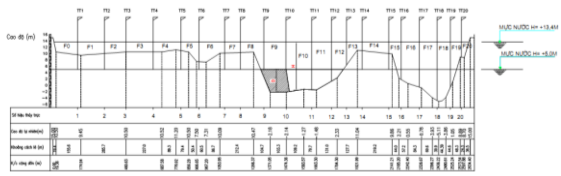


Figure 9. Location of hydrometers to measure velocity

Measurement and calculation results are shown in Table 2 and Figure 10.

Formula (5) can be rewritten as follows:

$$Y = AX^{\eta_2} \tag{6}$$

Where:

$$Y = \frac{Q_0}{Q};\quad A = \left(\frac{b_0}{B}\right)^{\eta_1};\quad X = \left(\frac{H-D}{H}\right)$$

From the relational chart in Figure 10, the expression (6) is determined: η_1=1.0063; η_2 = 0.536

Formula (5) in the general form as follows:

$$\frac{Qo}{Q} = \left(\frac{bo}{B}\right)^{1,0063}\left(\frac{H-D}{H}\right)^{0,536} \tag{7}$$

Replace the values b_0 and B in formula (7), we get the formula for calculating the flow over the top of the spur dikes at Tam Xa, Red River section passing Hanoi:

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$$\frac{Qo}{Q} = 0,06\left(\frac{H-D}{H}\right)^{0,536} \quad (8)$$

IV. RESULTS AND DISCUSSIONS

Table 2. Calculating parameters according to the elevation of the spur dikes

TT	Debit Q	Debit Q_0	Y	H	D	(H-D)	X
1	24166	1037	0,042911529	15,46	7	8,46	0,547218629
2	24166	1017	0,04208392	15,46	7,5	7,96	0,514877102
3	24166	981	0,040599714	15,46	8	7,46	0,482535576
4	24166	945	0,039117718	15,46	8,5	6,96	0,450194049
5	24166	917	0,037945874	15,46	9	6,46	0,417852523
6	24166	870	0,035997054	15,46	9,5	5,96	0,385510996
7	24166	830	0,03434553	15,46	10	5,46	0,35316947
8	24166	788	0,032622192	15,46	10,5	4,96	0,320827943
9	24166	745	0,030816155	15,46	11	4.46	0.288486417
10	24166	699	0.028913428	15,46	11,5	3,96	0,25614489
11	24166	650	0,026895508	15,46	12	3,46	0,223803364
12	24166	598	0,024737017	15,46	12,5	2,96	0,191461837
13	24166	541	0,022401453	15,46	13	2,46	0,15912031
14	24166	479	0,019832808	15,46	13,5	1,96	0,126778784
15	24166	409	0,016936673	15,46	14	1,46	0,094437257
16	24166	320	0,013241745	15,46	14,5	0,96	0,062095731
17	24166	223	0,009227841	15,46	15	0,46	0,029754204

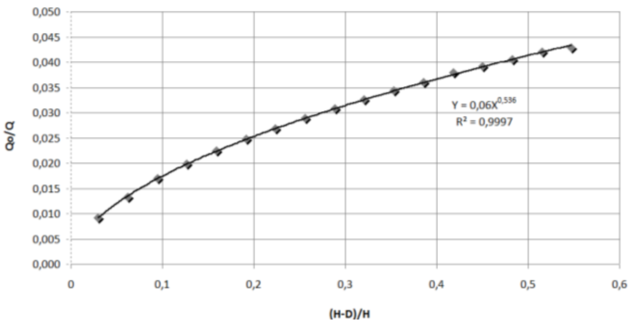

Figure 10. Relationship chart $Y = (\frac{Q_0}{Q})$ **with** $X = (\frac{H-D}{H})$

By analyzing the calculation results, to minimize the conductivity of the guide in the area of the torch body, it is necessary to reduce the flow through the top of the spur dikes, which means to reduce the depth of the spill on the top of the spur dikes, or in other words is to improve the process of spur dikes. However, the height of the spur dikes is also related to the object of adjustment, which is the river bed in the middle water season, the flood season or the dry season. If the subject of treatment is a river bed in a flood of large-scale Construction works, the time of occurrence of flood water level is very short to promote the economic and technical efficiency. Objects of effective treatment for integrated exploitation of river sections are river beds in middle water season. Therefore, the height of the spur dikes project is reasonable to be higher or equal to the elevation level (horizontal level of middle water).

V. CONCLUSIONS

Through analysis of actual materials, the research results on physical models of the effect of flooding level on the top of the spur dikes for spur dikes mine project is arranged in Red River section through Hanoi. The author has calculated and drawn, the greater the level of submergence on the top of the spur dikes, the larger the flow over the spur dikes tip, this transformation follows a positive relationship, which is very detrimental to security. The whole of the project as well as the river corrective effect, the reason when the spur dikes will work as a spillway, increases the risk of local downstream spur dikes. To limit erosion in the body of water (the space between the two spur dikes), minimize the flow through the top of the spur dikes by raising the top of the spur dikes. The determination of the spur dikes crest elevation relates to the economic-technical problem, stabilizing the river section to adjust and the efficiency of integrated exploitation to serve the relevant economic sectors. Objects of effective treatment for integrated exploitation of river sections are river beds in middle water season. Therefore, the height of the spur dikes project is reasonable to be higher or equal to the elevation level (horizontal level of middle water).

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AUTHORS PROFILE

Kien Quyet Nguyen, born in 1973 in Hung Yen, graduated from the University of Civil Engineering and received a doctorate in engineering in Construction of Waterworks at the University of Civil Engineering; Associate Professor of University of Transport Technology. Mainly teach and participate in scientific research projects at all levels of river, estuary and coast hydrodynamics. Main areas of research: application of mathematical models and physical models to analyze hydrodynamic regimes in natural conditions and when building river corrections, adjusting river mouths, embellishment and protection works coastline, thereby proposing solutions to layout space and structure for different types of works, to ensure safety to achieve economic efficiency - technical

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. He is the Advisor of more than 200 bachelors, 40 masters, 2 PhD specialized in hydraulic construction.