MINISTRY OF EDUCATION AND TRAINING
VIỆT NAM ACADEMY FOR WATER RESOURCES

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Study relieving subsurface hydrostatic pressures under some essential routes of river dykes in HaNam province and propose adequated methods to control them

Specialization: Construction of Hydraulic Works;
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PHD. THESIS IN BRIEF

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Date:…………………………………………………………..

The thesis can be obtained at : Việt Nam Academy for Water Recources

INTRODUCTION

1. The required of problems thesis

One of categories looks public construction of hydraulic works in Ha Nam Province, dikes and sluice ways used an location especially important. Historical many incidents happened dike break, threaten safety of lives and property of people in the region to defend. Recently, at 01/8/2012, happened Tac Giang dike break genitive Huu hong dike routine. it had serious consequences. Causes are due to pipeline under the major dykes and sluice under the dyke. Because of Ha Nam geology has heavy hydraulic conductivity, connection rives, thin impervious top stratum. Beside, the fisheries'pond had not almost top stratum. So that, high level river has been piping, soil boiling what dikes effect safety. Specially, it has happening sluice what has been construction at old river. Many solutions has been using as fill pond, relief wells. However, some of them were not fill pond allowed or area is thin top stratum. It is location especially flood prevention.

So that, thesis are research, applying advanced techniques to stabilize the permeability to fit the specific conditions of Ha Nam Province. This problem is very important and necessary for the management dykes of Ha Nam Province and the dikes of country in general.

2.The purpose and object of the thesis research:

Research objects: Hydraulic pressures under subsurfaces effect to the safety factor of river dykes (uplift pressure, piping or internal erosion) occurred river dykesof HaNam provinces

Research purpose: Study effectived alternatives to reduce excess hydrostatic pressures and controll piping for some essential routes of river dykes in HaNam provinces.

Research scope: Most risk reaches of river dykes in HaNam provinces

3. The studied methods:

In site methods: Collected geotechnical data, investigated and seveyd insufficient data to establish geological maps of dyke routes in HaNam province to use in flood control and dyke management activities.

Theory methods: The documents (technical books and papers, technical standards, ...) in Vietnamese and foreign languages were reviewed and applied in research process.

Practiced methods: Checmical grouting (binders are mixxing of glass water and cement) is expected to apply in emegency treament, so samples should be test in laboratories as well as in site.

Mathematical modeling: Studied on mathematical model and compared the results with analytical methods.

4. Research scope

Most risk reaches of river dykes in HaNam provinces: Huu Hong dike; Ta Đay dike, Nhue dike.

5. The content and layout

The content consists of: introduction, 4 chapters and a conclusion. The whole thesis is presented in the notes to 106 pages, 60 figures, 24 tables, lists of the author's works, references and appendices.

6. Main result and conclusion

1. Based on seepage safety behavious for river dykes, the author have collected available geotecnical data and supplement investigations to establish geotechnical map for dyke routes in HaNam province. That is very usefull in practice of flood control and dyke maintenance activities. The author used theorical method as well as finite element method (FEM) to estimate seepage safety factor for some essential routes. The conclution was that: with practical geological conditions of river dykes in HaNam province we can use simplization scheme as guided in US EM 110-2-1994 instead of using FEM to estimate safety factoty of dyke seepage in FS steps.

2. In practical site of HaNam with many aquaculture ponds available in behind of dykes. In case of impossible to refill it, the author proposed the way to reduce excess hydrostatic pressures and controll piping by using sheet piles well. The well created by soil – cement overlap columns was proved is effective in comparision with other methods.

3. In order to treat piping in emmegency situations, the author proposed and presented some primary results of using cement – chemical grouting to stop seepage flow.

4. Results of study results in thesis is very valuable and effective in practice of flood control and dyke maintenance activities in HaNam province.

CHAPTER 1
OVERALL STUDY ABOUT PROBLEMS

Ha nam province'dike and some problems caused by piping or internal erosion

The situation dyke Ha Nam Province

Ha Nam is low-lying and heavily influenced are by flood waters from upstream overflow. Dike system of more than 319 km provinces in which to grade I to III (Huu hong dike and Ta day dike) near 90 km long dykes IV (Song nhue river, Chau giang River, Hoanh Uyen, Ha Tay + Duy tien water barrier) longer than 98 km ...

Although the annual budget of the central government and localities to spend several billion for maintenance of dykes. But due to the geological conditions dike complex circuit flooding still occurs in the extruder circuit effervescent key positions and a number of culverts under the dyke. Some places even have occurred to serious incidents.

The sand boils, piping problems during flood season

The sand boils usually occurs where the aquifer (sand) with large thickness, with the thin impervious top stratum has strength (mechanical, permeability) high.

The piping usually occurs in areas where shallow aquifers are distributed near the downstream toe, toe to 0 ÷ 20 meters from where the individual is between 100 ÷ 200 m. River levels rise higher the vessels appear more sparkling and usually concentrated in key positions in corporations or circuit effervescent sparkling beaches, especially at the pond behind the dykes.

The piping under foundation and cut -off wall of sluice

The previous literature has summarized the problems that the majority are broken dyke at the drain location. The most recent incident happened sparkling extrusion, subsidence in sewers and docks Tac Giang Sub-irrigation systems projects Tac Giang - Ha Nam. The cause was initially identified by underground erosion in the background and brought tribute. Seepage comes from the two sides to talk to bring tribute. Through this shows the bottom drain waterproofing dykes, drains, especially on the complex geology and related seepage under the dyke.

1.1 The studying under the dike seepage deformation

Foreign research

For caculate the hydraulic pressures, in reason theory as well as to execute release of the given, multiple method has depend on current situatation of hidraulic work. The author as

NN Pavlopxki, XN Numenrov, RR Tsugaev, R.Whitlow have problems export multiple method for solutions however per methods will be any limit individual.

Seepage under the dike during flood season is unstable flow. According to the analytical method Sextakov VM, can determine the pressure increased permeability of flat line on the diagram unstable half permeability limits (margin scheme has a variable water level, while the other boundary at infinite separation) by linear equations of groundwater movement over time (Butxinet). This model fit under the dike seepage problems during floods. However, to solve this problem should have the tools and proficiency.
For simplicity for users, 1956 Waterway Engineering Center of the U.S. Army [24] has developed seepage under the dike model with the following assumptions:

a. The seepage is thought impervious riverside top stratum in to aquifer (sand).

b. The vertical seepage is thought impervious riverside top stratum. The horizontal seepage is in to aquifer (sand).

c. The levee (include both upside and downside berm) is impervious body.

d. The seepage is gravity flow.

e. The seepage model has simplified as follows: The sand (or gravel) is modeled as uniform in thickness and permeability coefficient. Floor waterproof coating (waterproof or weak) in thickness and permeability coefficient alike. Water lever on the lower cover depends on: the distance from the edge of the river dike, the dike size, thickness and permeability of the waterproof layer, thickness and permeability coefficient of upper-lower cover . On that basis dike seepage under the 7 simulated case studies cited in Appendix I of this thesis.

Domestic research

Some of the Vietnamese'author has been studing about the seepage deformation under the dike. Nguyen Cong Man has modeled some mechanic for dikes design. Date 2006, Pham Van Quoc has studied unstable flow by the physical models. Date 2002, To Xuan Vu has studied seepage deformation under the Huu Hong dike (Ha Noi section) and propose solutions to reduce the hydraulic pressures by soil cement. However, in 2010, Trinh Minh Thu and nnk has proven soil cement' solutions low efficiency when considering 3D problems. In 2009, Bui Xuan Truong has studied seepage deformation Hong river at Thai Binh area and propose to used the membrane for riverside...vv. So that, dike seepage under pressure depends on the geological structure of each dyke and stable solution repellent made only in accordance with the specific circumstances of the dyke.

The solution to treat piping, sand boil

Thesis summarizing, analyzing strengths and weaknesses and the scope of application of the absorbent solution stability dykes have been used, such as waterproof coating covered yard outside dykes and drainage up the pressure in the reaction dykes built system pressure relief wells; waterproof trench walls. etc. Since then show that, with the lake behind many such dykes in Henan, to ensure normal production people need to research to find solutions for steady seepage ponds without filling.

The thesis also summarizes experience extrusion processing piping of the sluices sparkling under dyke, especially troubleshooting experience Tac giang dam, August 2012. Specifically, the technical solution process immediately as follows: (1) Prioritize upstream cofferdam construction to balance water; (2) Construction of the cut-off wall by steel piles; (3) Construction of the soil cement create the cut-off wall to upside by Jet Grouting; (4) Fill empty slots under the sluice by cement sand. However, in the early days when not done upstream cofferdam embankment, the Jet-grouting drilling in cement also difficult due to seepage is strong. Only when they stop work cofferdam new drilling results as desired.

Through Tac Giang dam incidents showed troubleshooting work underground erosion during floods, the disparities conditions upstream downstream water level is very difficult and requires a technology suitable drilling equipment and the new age can be treated. So, in this chapter thesis presents an overview of the drilling technology to be studied in deep.

The overall study of grouting technology

Grouting is the process of bringing a mixture of grout (liquid or gas) into the slot on soil / rock cracks or voids / empty aims to reduce the permeability to the extent necessary, or strengthening the stability and strength of them, or both. Figure 1 shows the preliminary drilling technology is mainly present..

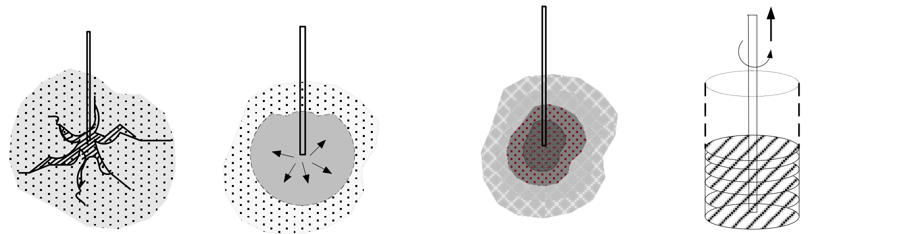

Figure 1. The kind of grouting technology is mainly present

The effect of drilling depends on the ability to penetrate the mortar grouting rock environment. The research and practice have proved that pure pressure drilling technology traditionally used cement ineffective in the sand, sand. In this case use ultra fine cement or chemical grouting, drilling technology using high Jet pressure (JG) or osmotic drilling, including drilling chemical grouting is a new problem for Vietnam .

1.5 The chemical grouting method

Chemical Grouting method is the active chemical solution injected into a layer of soil and rock to improve the mechanical properties of it . Currently, chemical engineering drilling fluid is used primarily glass. Liquid glass and chemical neutralization can be flashed separately (also known as two- way solution), or mixed together before grouting (a method of solution). When flashed separately , they can be flashed simultaneously or in sequence . To increase the durability of mortar over time , we now drilling chemicals used in conjunction with cement. However, doing so requires more complex equipment and the selection of grouting mortar aggregate ratio becomes much more complicated. The main applications of chemical grouting include: (1) Prevent, cut-off seepage, flow in soil , rocks;(2) Increase the bearing capacity of soil , rock ; (3) Repairing defects works.

The chemical grouting method can effectively prevent the penetration of land lines, even when there is flow. So choose the chemical grouting method thesis combines cement to study in chapter 4 for the purpose of handling emergency erosion phenomenon underground culverts under the dike and dike.

Concluction chapter 1

1. The system dykes located in Ha Nam Province is difficultly geological conditions, usually annually occur sand boil, piping, even cause serious problems.
2. Research stabilize the dike seepage was more domestic and foreign authors concerned. However, due to the complex nature of the geology dike red river delta to the research work in the country are limiting the scope of research in a specific geographic area.
3. The solution treatment dike stable is many methods, from traditional ways to the new solution proposed recently. Due to the complexity of the proof environment so each solution has its limitations, even after the solution was negative earlier proposed solutions. To say that that the proposed solutions to suit each specific conditions in accordance with the recommended structure still needs to be further studied.
4. From the fact that the flood prevention work of the author himself, the existing technology in Vietnam do not meet the requirements of troubleshooting permeability dike foundations in emergency conditions. Research chemical grouting technology combined cement chemicals to handle emergency effervescent extrusion phenomenon of flooding is also necessary issues in the prevention of floods in Ha Nam in particular, for the whole country in general.

CHAPTER 2
CLASSIFICATION OF HA NAM' DIKE FOUNDATIONS BY STABLE PERMEABILITY WIEWPOINT

2.1 The Natural features dyke Ha Nam Province

Nhue dike

Hong dike

Day dike

2.2 Classification of Ha Nam'dike foundation by To Xuan Vu' wiewpoint

The classification criteria soil is mainly based on the composition and origin of the sediments formed to provide names for each different soil types. It is not separate standards for soil classification in accordance with the purpose of assessing the dike seepage stability.

In 2002, Vu Xuan authors of doctoral dissertation research entitled "Assessing the impact absorption properties of some deformed sediments to stabilize the dike (for example a Red River dyke)" [15] made approach towards classification of "the structure foundation". The sensitivity of absorption depends on the presence of small particles of sand layer (Thai binh type), the thickness of the thin impervious top stratum system of Vinh Phuc foundation, distance from the river dike.

It has including the following type construct:

- The type soil are **very sensitive** with seepage deformation: I_1;
- The type soil are **sensitive** with seepage deformation: I_2, I_{2a}; I_3; II; III_1;
- The type soil are **less sensitive** with seepage deformation: I_{2c}; I_3; I_4; III_2;
- The type soil are **sustainably** with seepage deformation: III_3;

Under such an approach, the thesis was to collect geological survey documents of the dikes in the province of Ha Nam, the segment had no material additional surveys. As a result, the thesis has built map geological structures across the dike Ha Nam province presented in Appendix 11 of the thesis.

From the geological structure map can also point out some key paragraphs (sensitive permeable sand layer in which small particles are shallow, near the river dyke (Zt <3m and the distance from the river dike S <500m).

2.3 General remarks on the geological dykes Ha Nam Province

After analyzing geological data collected and the recommended additional survey, the thesis reviews the geological structure of dykes in Ha Nam province as follows :

- Body dike embankment is more cohesive, derived from alluvial layer coated on the surface, the coefficient permeability k ~ $10^{-6} \div 10^{-8}$ cm/s;
- Next layer is coated on the surface sediments have variable thickness, usually from 1 to 8m, with weak performance waterproof, coefficient permeability k ~ $10^{-5} \div 10^{-7}$ cm/s;
- The bottom layer of the coating is waterproof up sediment (coarse sand, fine sand, sand, ...), permeability coefficient is usually k ~ $10^{-4} \div 10^{-6}$ cm/s; aquiter layer thickness from a few meters to tens of meters (with the drilling of up to 40m are still not finished).
- End of layer waterproof layer of hard clay or bedrock, often referred to as a non-aqueous layer.

Simulation can simplify cross dike Ha Nam Province in 7 cases [24], as follows:

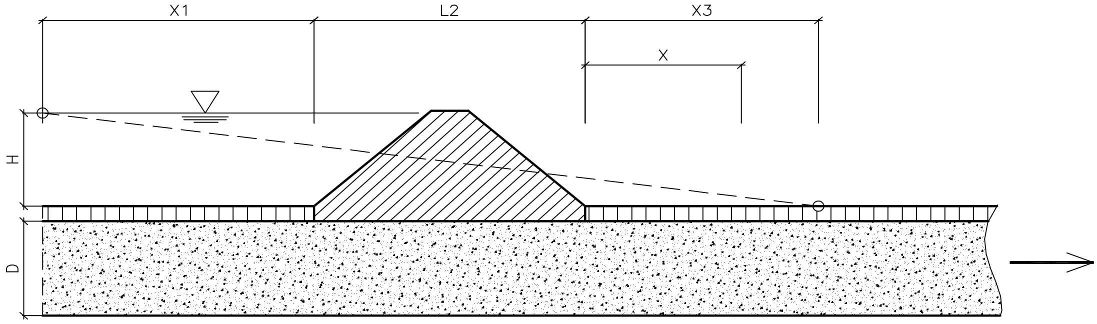

Figure 2. Simulation can simplify cross dike Ha Nam Province

With such a structure should the flood season, the river level will rise in the deep layer of the aquifer, push upward pressure on the bottom of the impervious stratum. At the seat cover with holes (wells, canals were dredged, ...) water will exit. When water drains in the area surrounding the seepage pressure under the coating will decrease, but the risk of seepage flow will lead to the same fine particles escape, causing erosion and piping.

2.4 Safety reviews some focus dyke in Ha Nam province'dike

Because soil structure of dikes has not reflected in the hydraulic factor (Head water, gradient permeability) and have not quantified the safety of permeability. So, in this chapter thesis has simplified simulation dyke sections in the standard way as described in the U.S. [24], then calculating safe levels steady seepage with water level alarm in the I, II, III.

Geological map of the soil structure, including 3 positions:

- Hong dike: Km133+00 to Km133+400
- Day dike: Km103+00 to Km103+570
- Nhue dike: Km3+280 to Km4+250

The thesis has made 3 model for this 3 positions with alarming levels I, II, III. Use of mathematics formulas with simple diagram shown in Figure 2. The results are as follows:

Table 1. Data location and the water level of major dyke

Dikes	Location	Water level I (m)		Water level II (m)		Water level III (m)	
		Riverside	Landside	R.d	L.d	R.d	L.d
Hong River	Type I_{1a}: Km 133+0 ÷ Km 133+400	+5,2	+0,8	+5,5	+1,1	+7,1	+ 2,2
	Type I_{1b}: Km 142+500 ÷ Km 144+100	+5,1	+1,2	+5,3	+1,2	+7,0	+ 2,5
Day River	Type I_{1a}: Km 103+0 ÷ Km 103+500	+3,6	-1,5	+3,8	+0,8	+ 4,2	+ 0,8
	Type I_{2a}: Km129+400 ÷ Km133+00	+ 2,7	+0,85	+3,1	+0,9	+ 3,9	+ 1,1
Nhue River	Km 3+280 ÷ Km 4+250	+2,9	+1,2	+3,2	+1,3	+4,0	+1,8

(Sources:Department for Flood and Storm Dyke Management Ha Nam)

Table 2. Input data for calculating effective length uptream nature blanket X_3, Pressure head under impervious stratum at landside H_{av}, Gradient of major dykes

Type	Water level	Unit	Hong river		Day river		Nhue river
Nature lever ($\nabla_{MĐTN}$)			0,5	0,0	-1,5	-1,5	0,0
Total Head H	BĐ I	(m)	4,7	5,1	5,1	4,2	2,9
	BĐ II	(m)	-	-	-	-	3,2
	BĐ III	(m)	-	-	-	-	4
Head at check position h_{ao}	BĐ I	(m)	0,8	1,2	1,5	0,85	1,2
	BĐ II	(m)	-	-	-	-	1,3
	BĐ III	(m)	-	-	-	-	1,8
Soil type			I1a	I1b	I1	I2a	I1
Thickness of blanket Z_t		(m)	1,5	2,5	2	4	2,7
Cofficent permiability blanket K_b		(m/s)	5.10^{-7}	5.10^{-7}	1.10^{-8}	10^{-8}	5.10^{-7}
Thickness of aquifer D		(m)	55	53	40	40	45
Cofficent permiability of aquifer K		(m/s)	10^{-4}	10^{-4}	4.10^{-5}	4.10^{-5}	5.10^{-5}
Effective length from riverside to check X (*)		(m)	93	89	140	141	79
Length from riverside to landside toe S		(m)	43	39,47	90	91	29

Note:

- All problems are considered in the pond edge conditions from the toe 50 (m). Because the survey data in Ha Nam Province, the distance from the downstream toe to the edge of the pond 50 ¸ 100 (m).

- Total Head at uptream H = ÑMNTL- ÑMĐTN

- At the position of the Day river from Km 103 +0 to Km 103 +500 nature lever landside is high Ñ 0.0 (m). Section downstream of the pond have been carried out in Chapter III calculations..

The safety of head beneath top impervious stratum of major dyke on Hong, Day, Nhue River presented in Table 3.

Table 3. Calculating results of effective length uptream nature blanket X_3, Pressure head under impervious stratum at landside H_{av}, Gradient of major dykes

Type	Position	X_3 (m)	H_{av} (m)	h_a (m)	I_{max}	I_{gh}	Unsafe	
							Sand boil	Piping
Water lever I								
Hong river	Type I_{1a}: Km 133+0 ÷ Km 133+400	129	2,15	0,9	0,94	0,9	*	*
	Type I_{1b}: Km 142+500 ÷ Km 144+100	162,7	2,85	1,2	0,77	0,9	*	
Day river	Type I_{1a}: Km 103+0 ÷ Km 103+500	544	3,97	1,2	1,13	0,9	**	**
	Type I_{2a}: Km129+400 ÷ Km133+00	769	3,7	2,4	0,726	0,9	*	
Nhue river	Km 3+280 ÷ Km 4+250	110,2	1,254	1,62	0,32	0,9		
Water lever II								
Nhue river	Km 3+280 ÷ Km 4+250	110,23	1,384	1,62	0,346	0,9		
Water lever III								
Nhue river	Km 3+280 ÷ Km 4+250	110,227	1,73	1,62	0,384	0,9	*	

Note:

** The risk of unsafety*

*** The risk of serious insecurity*

X_3: effective length uptream nature blanket (m); H_{av}: Pressure head under impervious stratum at landside (m); h_a: Limit pressure head under impervious stratum at landside (m) (m); I_{max}: maximun calculate gradient ; I_{gh}: Limit gradient.

From the results calculated by analytical formulas, commented:

- For Hong'dike and Day'dike, the water level at an alarming I was going to risk pushing unsafe podium. The risk of erosion occurs for type I_{1a} of the Hong river and the Day river.
- For Nhue'dike, only when the water level III is make unsafety to push the stratum (sand boil)

2.5 Concluction chapter 2

- The stability of the dykes permeability depends on many factors: topography, geology, hydrology, ... look at the position.

- Classification of the geological of dike by the authors precedes relatively meticulous and demanding fully documentation to complete.

- For the dike of location Ha Nam province, the stability of permeability only depends on effective length from dike to river and thickess of landside impevious stratum.

- Simulation can simplify cross dike Ha Nam Province in figure 2 and using the analytical formulas to calculate the stability permiability for the dyke near the river. Calculation results show that:

+ The Hong' dike (Km133 to Km133 +400 +00) at risk of unsafety when water levels at an alarming rate I.

+ The Day'dike (Km103+00 to Km103+500) at risk of unsafety whent water level at an alarming rate II.

+ The Nhue'dike (Km3+280 to Km4+250) at risk of unsafety whent water level at an alarming rate III.

The caculating results accordance with manage the actual management of flood prevention in the province of Ha Nam. The position of the dyke major specified on the enclosed map.

CHAPTER 3
SOLUTION OF STABILITY PERMEABILITY FOR MAYJOR TA DAY'DIKE

3.1 The problem of stabilizing the dike seepage

Caculating seepage problems with analytical methods

- *Theory:*

+ The seepage is flow Darcy law;

+ Well penetration aquifer (perfect wells);

- *Schematic diagram:*

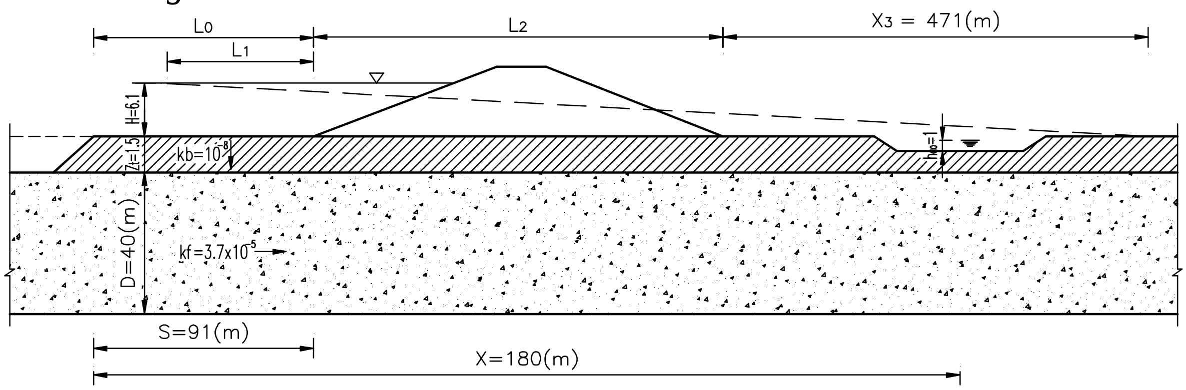

Figure 3. Model pressure head under imperious tratum

Effective length uptream nature blanket X_3:

$$X_3 = \sqrt{\frac{K}{K_b} Z_t D}$$

Therein: H – Total head (m); Z_t – Thickness of imperious tratum (m); D - Thickness of aquifer (m); K_b – Cofficent permeability of imperious tratum (cm/s); K - Cofficent permeability of aquifer (cm/s).

Pressure head under impervious stratum at landside H_{av}:

$$H_{av} = H\frac{S + X_3 - X}{S + X_3} < h_a = \frac{I_{gh}}{F_s} Z_t$$

Therein:

S – Distance from river to toe landside dike (m);

X – Distance from river to pond of position check (m);

h_a - Limit pressure head under impervious stratum at landside;

Z_t - Thickness of imperious tratum;

F_s – Safety factor, by 1,5 other caculating formula below:

$$F_s = \frac{I_0}{I_{gh}} = \frac{\frac{\gamma'}{\gamma_w}}{\frac{h_a}{Z_t}} = \frac{\gamma' Z_t}{\gamma_w h_a} \Rightarrow h_a = \frac{I_{gh}}{F_s} Z_t$$

Therein: I_o – Limit gradient pressure, the ratio of the specific gravity of the soil with a specific gravity of water;

Accoding Bui Van Truong author study [13], I_{gh} below:

$$I_{gh} = 0{,}476 \sim 0{,}433 \text{ (small sand)}$$

$$I_{gh} = 0{,}510 \sim 0{,} 453 \text{ (fine sand)}$$

Conditions safety sand boil:

$$I_{cgh} = 0{,} 735 \sim 0{,}742 \text{ (small sand)}$$

$$I_{cgh} = 0{,} 720 \sim 0{,}709 \text{ (fine sand)}$$

Caculating seepage problems by FEM Method

Using Seep/w software of GEO - Slope International Company - Canada. The water level in the river is taken by the highest water levels occurred in history (1971), the downstream water level is the water level in the pond (or wells), respectively. Exempted limited take from the river edge to 328m from the toe, is divided into triangular elements and quadrilateral, linked together by intermediate nodes. The model results in the following form:

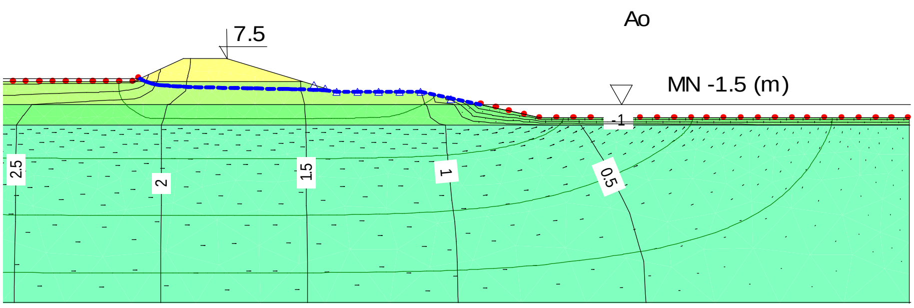

Figure 4. Calculation results of water pressure present case

3.2 Assess the stability permeability Ta Day dike

Location study

Location Research the area Km103÷Km103+200. Thesis choose this location to conduct research because this is the most important position on the entire dike system Ha Nam Province. In this area, the right is River, a river with an average elevation -2.0 m. On the banks of the rice fields, with an average elevation +2.7m ÷ +3.0 m. Recommended with an average elevation +7.0 ÷ +7.5 m. Pond aquaculture is an area of 7.000m^2. Lowest elevation -2.0 m pond.

Geology of dykes in the study area consists of 4 layers. Top soil is n^{o}1, is colored brownish clay, hard plastic state to semi-hard, with a thickness of 5.3 m ÷ 5. Next, layer 2 (cover layer) is the layer of gray-brown clay soft plastic state, 0.5 ÷ 2.1 m thick. Next, layer 3, is the gray clay layer recording, flowing gray plastic state, 1 ÷ 8m thick. Layer 4, the gray sand granules have tight status register, this layer thickness of about 40 ÷ 50m

Combination water level used to calculate:

- Combination 1, Water level I: Riverside: +3,6(m); Landside: -1,5(m).

- Combination 2, Water lever III: Riverside: + 4,2(m); landside: +0,8(m).

The case of caculating

Case 1: Assessing the dike current state, the calculated water level combined with alarming I.

Case 2: The problem of treat safety permeability, proposed three options: (1) Fill the pond, (2) Build relief wells, and (3) Build wells by soil cement. Calculate the water level combined with an alarming rate III. When calculated by FEM method, pressure relief wells are simulated free water column, permeability k= 3,0 x10^{-4} (m/s); Coefficient permeability of soil cemnet K_{tuong} = 3,16 x10^{-7} (m/s).

Table 4. Caculation results for case 1

Unit: m

Water lever river side	Water level land side	Analytical methods		FEM methos	
		H_{av}	I_{max}	H_{av}	I_{max}
+3,6	-1,5	3,467	1,387	3,477	1,39

Comment: The results calculated by analytical formulas and FEM model shows**,** at position pond is risk **boil sand, piping** when water levels up to alarm I. Compared phenomena occur in practice**,** the calculation results in relatively consistent.

Conclusion: There should be solution to stabilize the dike seepage.

3.3 Proposed solutions to improve the stability of the Ta day dyke

Solution fill the pond landside

Filling the pond to +0,8 (m), lower than the downstream berm.

Results from analytical methods larger than FEM methods, below:

Water level river side	Water level land side	Analytical methods		FEM methos	
		H_{av}(m)	I_{max}	H_{av}(m)	I_{max}
+4,2	+0,8	2,74	0,57	2,425	0,5

Conclusion: Ensure that the dike safety permeability when filling pond to +0,8 (m)

Solutions of system pressure relief wells

- Relief wells are arranged as shown in Figure 5.

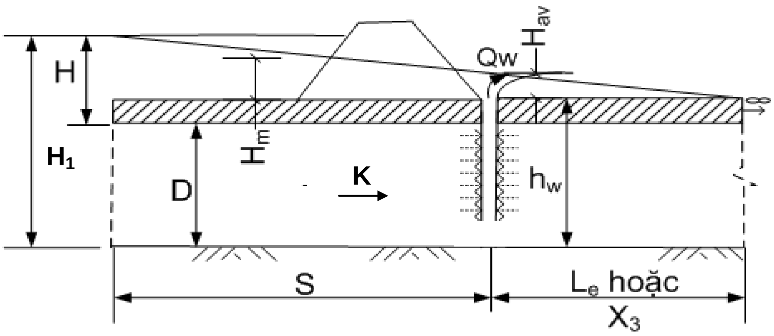

Figure 5. Treatment plan layout system relief wells

- Value H_{av} and I_{max} from Analytical methods larger than FEM methods:

Water level river side	Water level land side	Analytical methods		FEM methos	
		H_{av} (m)	I_{max}	H_{av} (m)	I_{max}
+4,2	+0,8	0,87	0,48	0,6	0,45

Conclusion: The result shows that, as relief wells distance 10m, 20m depth the phenomenon prevented podium pond. However, conditions at a later time if the user does not flush well, the efficiency of the wells down, down to the level of 50% is not safe anymore. Therefore, the thesis proposed solution stabilize the wells by overlap soil cement to replace relief wells to overcome this drawback.

Solusion well by overlap soil cement

- Well by overlap soil cement are arranged as shown in Figure 6. Where: P - depth wells, h_g - height of wells from nature ground.

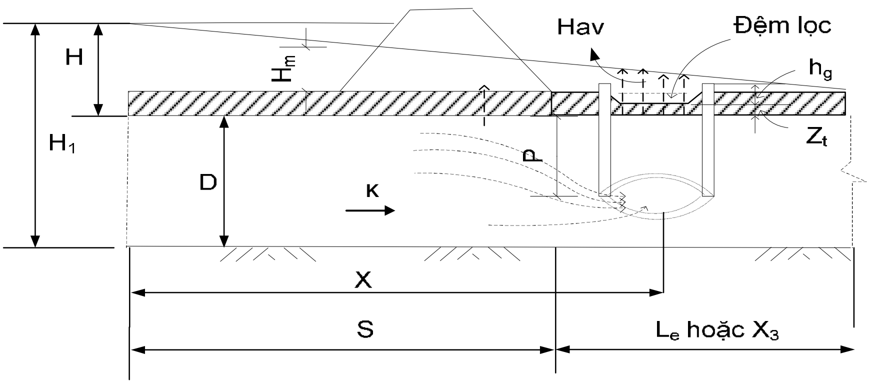

Figure 6. Treatment plan layout wells by overlap soil cemnet

Value H_g from Analytical methods larger than FEM methods,

h_g (m)	Analytical methods				FEM methos			
	1,5	2,0	2,5	3,0	1,5	2,0	2,5	3,0
P = 10m	1,466	1,25	1,09	0,977	1,4	1,25	1,05	1,0
P = 20m	1,41	1,21	1,06	0,944	1,3	1,1	1,0	0,9
P = 30m	1,37	1,17	1,02	0,914	1,2	1,05	0,93	0,85

Conclusion: Only depth wells P=10 (m) and height of wells from nature ground h_g =1,5 (m) is safety permeability.

3.4 Assess the economic efficiency

Funding schemes are calculated on the prices same time, the unit price as of June 2013.

Schemes	Fill pond	Relief wells	Wells by overlap soil cemnet
Funding (VND)	5.087.546.400	9.800.000.000	5.064.000.000

Conclusion: The plan to reduce pressure wells have the highest prices, plans fin piles wells and ponds downstream embankment schemes have approximately the same price. However, plans for wells enclosure poles has several advantages over: the land transportation environment pollution, social still aquaculture, transformation is not produced, no loss of arable land.

3.5 Concluction chapter 3

1.Treatment stability permeability for some major dyke is a urgent requirement in practice in the province of Ha Nam. In this chapter, thesis has selected one section dyke from Km103 ÷ Km103+200 to check seepage deformation. This dyke exist landside fisheries'pond, annually on the first alarm (upper water level +3.6) sand boil and piping appearance. Calculation results show that checks the status at the first alarm occurs due to piping. The plan was laid out filled pond, however not accepted.

2. Dissertation proposal and calculate 3 treatment options:

- Fill pond to + 0,8;
- Build system pressure relief wells at the landside toe;
- Create wells by overlap soil cement.

All 3 options are calculated with the water level alarm level III (the upstream water level +4.2), ensuring the conditions causing cracks in underground erosion phenomenon pond.

3. Calculating the head pressure of the dike can be calculated by the theory, based on the analytical formulas or calculated by FEM method based on commercial software. Theoretical results calculated in favor of safety. However, the basic design steps using the formula described in the thesis is acceptable.

4. Through analysis and selection, the authors propose 3 options to apply for the recommended treatment taught with the following parameters:

- Depth wells P=10 (m) and height of wells from nature ground h_g =1,5 (m), wells along the perimeter of the pond, the entire circumference of about 600m.
- Wells was create by overlap soil cement column and construction by Jet-grouting technology, presented chapter 4.
- High wellhead to + 0.8, or downstream berm.

5. With the same major dike can be used this methos for caculating and design.

CHAPTER 4
STUDY EXPERIMENTAL CHEMICAL GROUTING FOR THE EMERGENCY TREATMENT THE DIKE SEEPAGE PROBLEMS

4.1 The purpose and studied methods

- Research purpose: study about ability to apply chemicals grouting for emergency treatment the dike seepage problems.
- The studied methods: combined theoretical and experimental study in labory.

4.2 Practiced methods

Location conducting the test is clearing the landside, next to the Moc Nam' sluice, Duy Tien district, Ha Nam province at Km 123 +050 m on the Huu Hong dike system.

Geology

Results drilling geological surveys at the filed showed a soft clay layer (layer 3), about 3,7 m thick plastic, from -4,30 ÷ -8,00 m elevation. Below this layer is the layer of plastic flowing sand, fine-grained (class 4) of a thickness exceeding 40 m.

Piles testing

Study the difference between merely drilling chemicals and drilling chemicals to combine cement, construction thesis in the field 3 of 7 stakes experiments, in which the two column A1, A2 constructed by method of JG, pile construction method A3 drilling low pressure. Aggregate grout piles used for 1m^3 following:

Column	Cement	Glass water	H_2SO_4 (70%)	$NaHCO_3$
A1	750 kg	-	-	-
A2	750 kg	60 L	-	-
A3	200 kg	60 L	15 L	6 kg

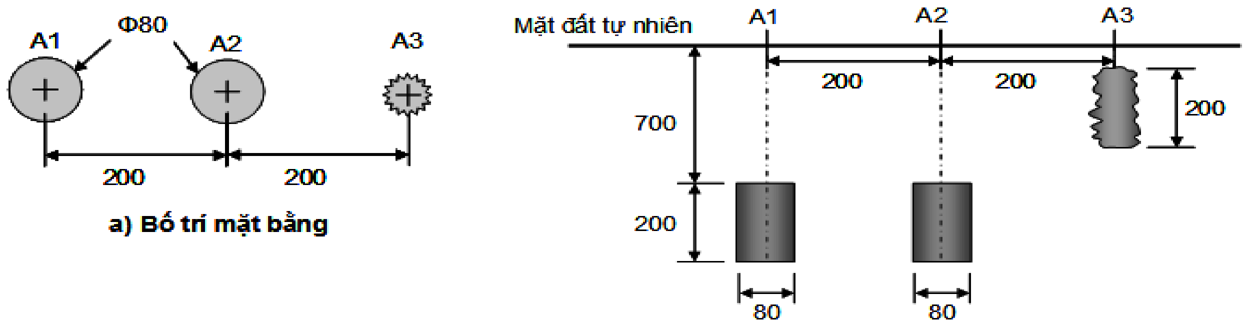

Figure 7. Schematic piles testing

The field testing

Experiments conducted in the borehole water poured piles and compared with experimental results in the natural soil, untreated.

4.3 Study laboratory experiments

The same times with piles tested in the field, the team has conducted laboratory model casting

The steps conducted model casting

- Mix cement with water in a 1:1 weight ratio;
- Mix with 380ml water 800g of cement sand mortar into fine;
- Dilute with water glass liquid volume ratio 1:4;
- Pour slowly the entire amount of cement paste made in step 2 into the sample tube (for chemical form: Filling glass with 100ml water dilution), just pour stir just until the initial setting mortar.

The experimental work

Thí nghiệm nén nở hông được tiến hành trên tất cả các mẫu hiện trường và mẫu đúc trong phòng bằng máy nén TYA-300C theo TCVN 3118.

Thí nghiệm hệ số thấm đất nền trước và sau khi xử lý bằng phương pháp đổ nước hố khoan.

Unconfined compression tests were conducted on all samples in the field and form molded by the compressor room TYA-300C according ISO 3118.

Testing the permeability coefficient before and after treatment by means of pouring water boreholes.

4.4 The study results

- Compressive strength of field samples after 28 days:

Name	**Type samples**	Unconfined **(kG/cm^2)**
A1	UC1	1,697
	M1	123,7
A2	UC2	0,867
	M2	121,0

- Compressive strength of labory sample:

Material	**curing time (day)**	**Compressive strength (kG/cm^2)**
Cement	1	10,9
	3	20,1
	7	37,7
Cement-Chemical	1	4,0
	3	11,2
	7	13,8

- Cofficient permeability nature soil (untreated): K = 4,079x10^{-4} (cm/s).
- Cofficient permeability soil after treating: K = 3,16 x 10^{-5} (cm/s).

4.5 Comment results

The phenomenon of rapid adhesive chemicals being put into the mortar grouting was confirmed through observation during the test piles in the field and in the preparation of samples being.

The results of field experiments on samples and prototypes are being shown, the treatment soil by using JG methos has a significant effect on the ability to increase compressive strength of the soil.

Use of cement - chemical effectively improved waterproofing for the large coefficient permeability, while ensuring long-term durability, can be applied to the dike seepage treatment in emergency situations.

4.6 Conclusions chapter 4

- Time gelatinized mixture of soil - cement depending on the mix of chemicals, can change between 3 to 30 seconds. Compared with the setting time of cement - construction land under high pressure drilling methods, the setting time of cement - soil - chemical accelerate.
- Using cement-chemical mortar to mortar grouting can improve the strength of markedly. Improve the level of intensity depending on the characteristics of the land. For example, for many soil sand content, increasing the efficiency of high intensity will be more than soil clay content.
- Mortar XM-HC is pumped into the pressure grouting method capable of improving the permeability coefficient significantly.

CONCLUSION AND RECOMENDATION

1. Conclusion

1.According to the classification recommended by previous authors, the thesis was to collect geological survey data and additional survey, conducted sorts the dykes, classification mapping should be left to the dikes in Ha Nam province.

Through the analysis of the geological structure of dykes, compared calculate seepage pressure thesis concludes can simulate simplified geological section dykes Ha Nam province as Figure 2 and using analytical formulas to calculate stability proof test in step up investment projects.

The thesis has shown a quantitative proof of the level of safety for key stage 3, which is: (1) Huu Hong dikes: Km117+900 ÷ Km118+600; Km119+400 ÷ Km119+800; (2) Ta Day dikes: K101 + 270 ÷ Km 102 + 130 và Km 103 + 00 ÷ Km 103 + 200; (3) Nhue dikes: K3 + 280 ÷ K4 + 250. The results calculated in accordance with the actual situation.

2.Thesis calculate permeability test for stability dyke' Ta day (Km103 to Km103 +200) and capable boil sand when the water level alarming II. The thesis proposed three options: (1) Fill the pond, (2) Build system pressure relief wells, (3) Create wells by overlap soil cement. All 3 options are safe when the river water level alarm level III. Dissertation proposal fins used as well as stakes in accordance with specific conditions and local sustainability.

3. Thesis research conducted test chemical grouting technology combined cement and the following conclusions:

- Using chemical glass of water mixed with cement can shorten the time of the gelatinized mixture between 10 ÷ 30 seconds, so can be used to treatment the flow'soil conditions.
- Using aggregate mortar XM/HC at a rate of 750 kg HC XM/60 liters (water glass) for handling emergency incidents underground erosion.
- The experimental study of the thesis is just the first step results in a specific project. Due to time and budget should not conditional thesis to research deeper and wider issues.

2. Recomendation

- Propound Ha Nam province using maps classification results in the dike thesis. Strengthen the management of dykes and flood control plans for major dyke
- In order to evade the need to build a system of wells reduced pressure, and the process must have regular maintenance in order to avoid the filter rule. The piece has many lakes

and ponds adjacent to the toe (Km103 ÷ Km103+200 Ta Day dikes) to build wells was create by overlap soil cement column and construction by Jet-grouting technology.

-Propose to use the results of thesis research on the development of common technical manuals in the design, maintenance and emergency incident handling the dike seepage

- It should continue to research the technology drilling chemicals, advanced to build the standard /technical guidance.

3. Thesis development

- Due to time and funding to build the geological zoning map by the sensitivity of permeability is not sufficient on all dikes. This study should be continued.

-The experimental study of chemical grouting technology is just the first step. There is a need to continue research and development to improve the technology, both in terms of materials and construction technologies. Specifically:

+ The scope of application: Extending the scope of application for the gravel, large rocks cracked, especially in the position of groundwater flow. In addition to waterproof the dike can also apply for research purposes and other types of work such as wall of lazzen, underground waterproofing...

+ The study material: Need to continue to further study the material properties cement-chemical. Especially the influence of the environmental factors of the ground (physics, chemistry), mixing ratio ... gelatinized to speed, the coefficient of permeability, durability, hardness ... of the material

+ The technology and testing methods, quality control: Need further research and development of detection technology and seepage detected position to assess the quality of the work after treatment permeability.

PUBLICATIONS OF THE AUTHOR

1. Nguyen Quoc Đat (2012), *Experience improve stability and treatment of the river dike seepage*, The journal of Science and Technology of Water Resources Institute, November, Ha Noi.
2. Nguyen Quoc Đat (2011), *Results of studies geological classify the Ha Nam province dike safety base on standpoint stable permeability*, The journal of Science and Technology of Water Resources Institute N^{o} 05+06 December, Ha Noi.
3. Nguyen Quoc Dung, Nguyen Quoc Đat (2011), *The chemical grouting technology for waterproofing and application capabilities in Vietnam*, The journal of structural building technology, Ha Noi.
4. Phung Vinh An, Nguyen Quoc Đat (2005), *Some problems about the column soil cement for stabilized pits*, The Journal of Agriculture and Rural Development ISN 0866 – 7020, Ha Noi.