FALLING THE GROUND WATER IN DEEP FOUNDATION PIT BY WELL SYSTEM IN CONSTRUCTION OF HYDRAULIC AND COASTAT ENGINEERING STRUCTURE

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Absctract: *The dewatering of foundation pit is influenced by the geological engineering condition of construction site, size of foundation pit, method of excavation, the influence to the adjacent works, therefore, the dewatering of foundation pit depends on work items as investigation, design and construction. Foundation dewatering by a system of surrounding wells is a popular and effective solution due to its high constructability and strong support of permeable theory. However, some cases have failed because of some objective causes. On the observation in the construction of Van Coc culvert in details from the begining, the author has used the Modflow software for the recalculation and obtained the results that in accordance with the actual state. Based on the mentioned case, the author has analyzed and shown considerations on the causes that happened during the investigation, design and construction for solving the failure in foundation pit that dewatered by pumping out from well systems.*

Keywords: Van Coc culvert, Hiep Thuan culvert.

1. INTRODUCTION

The underground water is commonly lowered below the bottom of foundation pit for construction works in general, hydraulic works in particular. In these cases, the water falling for dry foundation is necessary. The water falling work is implemented by methods that depending on the geological condition, size of foundation pit, excavation method, influence to adjacent works etc. In suitable condition, water pumping-out from surrounding wells is selected.

The method of water pumping-out from well system is selected on follwing basic advantages:

- Since hydraulic gradient is generated opposite to the dip driection of foundation pit slope, the flowing of sand and the collapse of foundation pit roof are controlled.
- Pit bottom is not obstructed by dewatering instruments, which is convenient for construction.
- Underground water level is actively fallen below the pit bottom, convenient for construction.

The method of water pumping-out from well system is designed with regards to the issues of mutual effect in hydrological geology. Based on the principle of action (theory of flowing addition), in layout of wells with well distance *(a)* < 2 radius of well (R) then the water level in the range of wells is fallen in certain value (s). Falling the underground water under pit bottom is actively implemented based on the available data such as permeable coefficient of soil, size (radius and length of filter pipe) of well, selective distance between wells (figure 1).

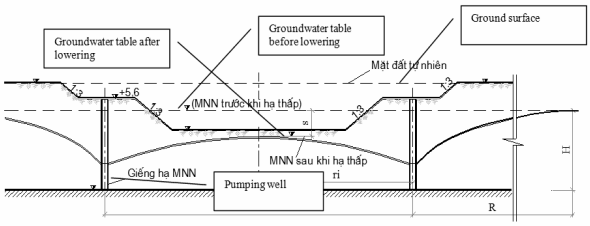

Figure 1. Layout of water falling for dry foundation pit bottom (lowering groundwater in building pit) by interactive well system

2. CONTENT AND METHOD

On the theory, the problem is solved for the situation of stably permeability flow and unstably permeability flow depens on the time of foundation pit excavation. However, in construction works, many cases have been failed in falling the groundwater down to the required depth. In the scope of this article, the example of Van Coc culvert is offerred as follows:

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- Size of foundation pit: width (53,6m), length (90m), depth (10,6m), water level > bottom level of foundation pit (4,7m).

- The strata is of 5 layers downward as follows:

Layer 1 and 2: clay, sandy clay in the stiffly plastic state.

Layer 3 and 4: clay, loam in the stiffly plastic state.

Layer 5: fine sand with permeable coefficient $k = 5.10^{-4}$m/s.

Based on above data, the needle wells had been used for calculating and designing the waterlevel falling by consultancy with well number (105 wells), well depth(14,6m), well distance (2,7m), total volumetric flow of pumping (3.200m^3/ngd). The pumping work had been conducted by a contractor since 10/2003. After that period, this contractor was withdrawn and replaced by new one because of the failures in waterlevel falling for dry pit foundation bottom. In order to repair these defects, a new project was considered and it was recognized that failure causes are unreasonable length of filter pipe, unreasonable design diagram of permeability, unreasonable filter pipe for geological condition causes effect of high skip, limitation of alternatives. The Mapflow software was selected to design a solution to these mentioned failures. Modflow software is professionally based on the finite difference method of 3-D permeable problem. Modflow software can solve the problem in short time with many different alternates.

As mentioned above, groundwater level falling is carried out with reasonably permeable theory. In addition, method of groundwater level falling should be in minimum charge. In order to solve this problem, length of filter pipe, depth of well and well distance were changed. In detail, the selective net of square shape (size of 0,5 x 0,5m) and square triangular shape (size of 0,5m) were divided. The well layout was arranged surrounding the foundation pit as follows:

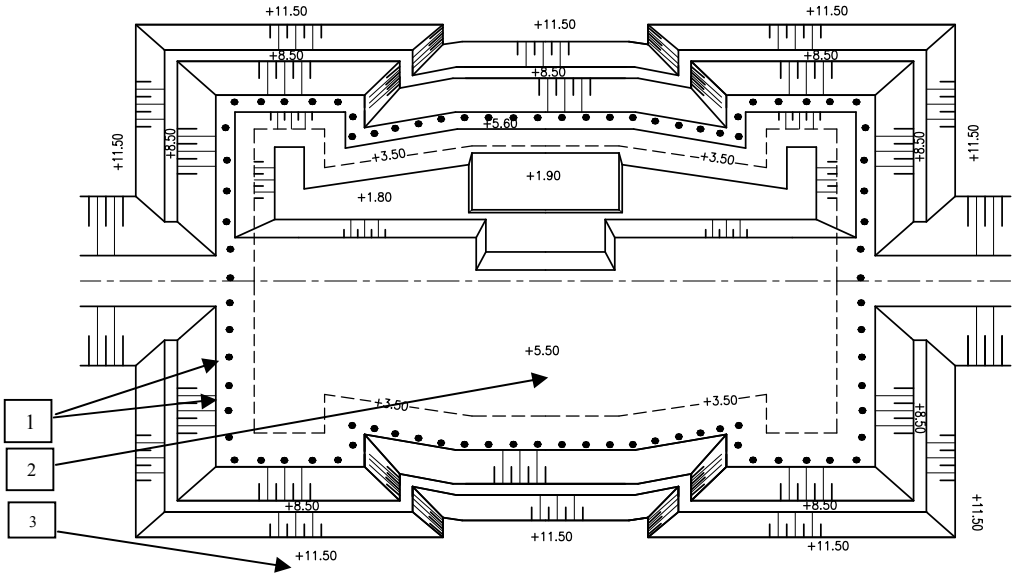

Figure 2. Well layout, 1. well, 2. level of foundation pit bottom, 3. level of foundation pit roof

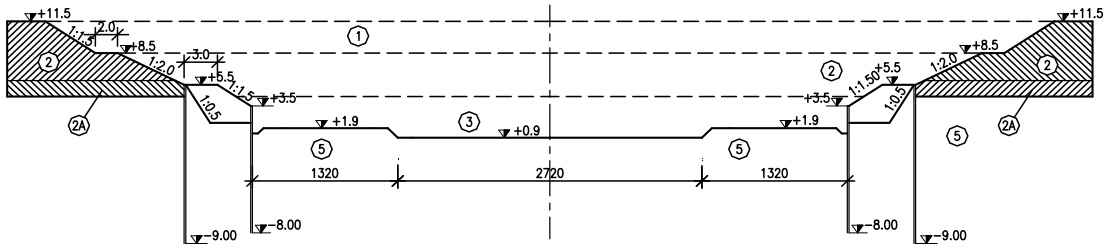

Figure 3. Van Coc culvert – Cross section of foundation pit

The total calculation was 24 plans with 4 plans for each variable of filter pipe length, well distance and well depth. Among them, the most economic, reasonable plan was selected with 84 wells, filter pipe length of 2,5m, well depth of 14,5m, well distance of 3,4m. The cone of water level falling is shown in figure 5 and 6.

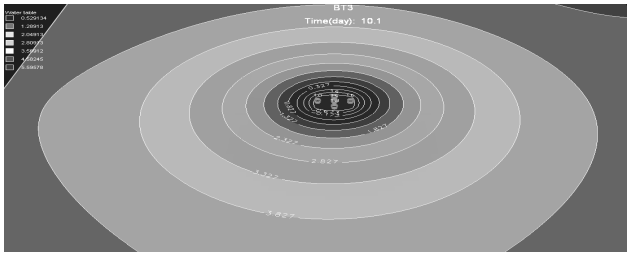

Figure 5. groundwater level is decreased by continuous pumping in 10 day

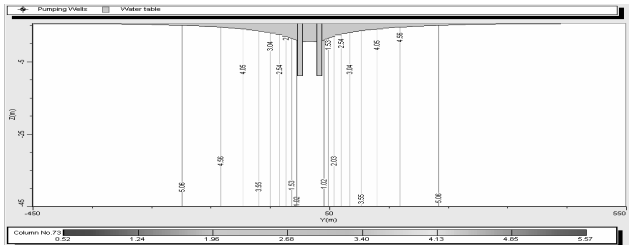

Figure 6. Horizontal section of foundation pit axis

Based on results of these design, the water falling for dry foundation was achieved by contractor. Layout of wells in selected plan is arranged in figure 7.

Figure 7. Sheeting piles, wells were arranged surrounding foundation pit for groundwater falling in Vân Cốc culvert with Chinese pump/well

3. RESULTS AND DISCUSSION

First of all, we would say water level falling by pumping out from surrounding well system is feasible because the basis of method is mutual action of well system with small well, besides, the theory of this problem is strictly valid. Then, what causes the failures in applying? Our answer is the mistakes of either investigation or design or construction or all of them.

Figure 8. Hiep Thuan culvert was excavated in dry condition.

On the investigation, 2 parameters are related to the effect of method, they are stratum condition and permeable coefficient of layers. The permeable coefficient of soil layers is determined by field test or laboratory test. In design, the laboratory test results are not very accurate. In some examples, the volume of wells had to be multiplied up to 50% to meet the requirement of dry foundation pit. The wrong strata will bring to the wrong selection of permeable layout.

As mentioned above on design, basis of method is using the effect of mutual action of wells. With small well distance, the water falling level **"*s*"** at any point in the scope of well is calculated as follows:

$$s = \sum_{i=2}^{n} \frac{Q_i}{4\pi kH} \ln\left(\frac{2.25kHt}{r_i^2 S}\right)$$

The basis of this design is that wells are arranged with the distance to required point r_i to obtain the value *s* for the groundwater level below the foundation pit level. In general,

incomplete well system is used in water falling for saving the cost. Then, $s_{khc} = s + \Delta s$, in there Δs is additional water falling level generated by effect of incomplete well system. The problem is more complex by the calculation of Δs. For the correct calculation of □s, the chart should be correctly selected on the basis of incomplete level of well system.

When filter pipe is arranged at the locations close to the roof, in the middle, close to the bottom of water bearing formation or if located in many segments as in sample *d,* at figure 8, then value Δs will be very different. The wrong determination on geological condition will bring to the failure in design as mentioned above. In general, the permeable problem of incomplete well is very complex so mentioned examples are only for references.

Besides, filter pipe can influence to the effect of water falling method. In general principle, the permeable coefficiency of filter pipe should be higher than permeable coefficiency of the surroundings. In other words, filter pipe is not allowed to damage the hydraulic power of infiltration flow besides the infiltration flow. In case of wrong type of filter pipe, the hydraulic power is damaged, the skip will be considerably increased and will mislead the calculation results of water level falling. For example, the needle well system should apply for strata of fine sand. For medium or coarse sand, the hydraulic power will be damaged, which will mislead the calculation results of water level falling.

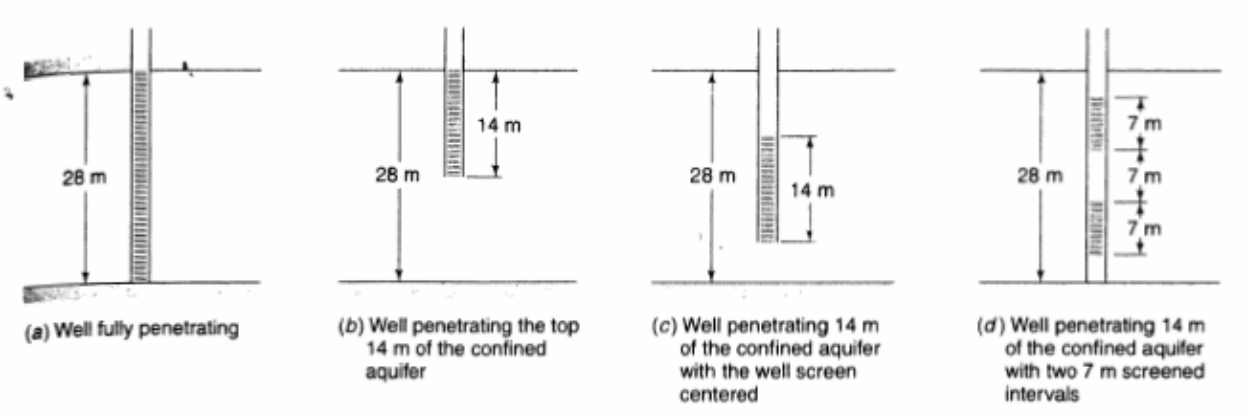

Figure 8. Layout of filter pipe in water bearing foemation

On the construction, the design and method should be strictly implemented, if not, the effect of underground water is low, soil is compacted in the vicinity of the wells, permeable coefficient is decreased tending to the reduction of flow ratio, the water level falling is decreased between wells.

4. CONCLUSIONS

- The method of water falling for dry foundation by pumping out from foundation pit surrounding wells is reasonable because the permeable theory is valid, groundwater falling active meets the required depth, opposite permeable gradient is generated for recovering the underground erosion, sand flowing, ground blowing up and excavation restraining.

- In order to successfully utilize this method, the investigation, design and construction should be strictly conducted. Contractor should cautiously review the documents of design before construction.

- Modflow is a advanced software, besides permeable theory should be clearly understood for selecting the reasonable layout. Permeable field test should be considered in design. Reasonably safe coefficient should be considered in using lab test results if necessary.

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Tóm tắt:

HẠ THẤP MỰC NƯỚC NGẦM CỦA HỐ MÓNG SÂU BẰNG HỆ THỐNG GIẾNG KHI THI CÔNG CÔNG TRÌNH THUỶ LỢI, THUỶ ĐIỆN

Công tác tiêu nước hố móng liên quan đến điều kiện địa chất công trình của khu vực xây dựng, kích thước hố móng, biện pháp đào móng, khả năng ảnh hưởng đến các công trình lân cận vì vậy, nó phụ thuộc vào cả ba khâu: khảo sát, thiết kế và thi công. Giải pháp tiêu nước hố móng bằng cách hút nước từ hệ thống giếng bố trí xung quanh là giải pháp thông dụng, hiệu quả vì có cơ sở lý thuyết thấm chặt chẽ và thuận lợi trong tổ chức thi công. Tuy nhiên, cũng có trường hợp đã không thành công vì một số các nguyên nhân khác nhau. Bằng trường hợp cụ thể của cống Vân Cốc mà tác giả là người đã quan sát từ khi khởi công, tác giả đã sử dụng phần mềm Modflow tính toán lại và kết quả đã phù hợp với thực tế. Thông qua trường hợp này tác giả đã phân tích và đưa ra những nhận định về các nguyên nhân ở trong cả ba khâu khảo sát, thiết kế, thi công có thể làm cho giải pháp tiêu nước hố móng bằng bơm hút từ hệ thống giếng không thành công.

Từ khoá: Cống Vân Cốc, cống Hiệp Thuận.

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