Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2013 JNAS Journal-2013-2-11/622-626
ISSN 2322-5149 ©2013 JNAS

Physical Consideration of the Water Filtration in Choghazanbil Ziggurat

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ABSTRACT: The present study basically deals with the construction of the small pond in particular and the water filtration in general in Choghazanbil which is considered the valuable memorial of Ilam civilization constructed near Susa, Khouzestan. According to the reliable views, there are two hypotheses about this small pond. 1. The existence of multiple drain pipes shows that Ilamian paid attention to the necessity of protection system and water discharging with regard to the material quality and the weather of that time 2. When the bigger pond became full of water and the water level became on the same level with the margin of its ending wall, according to the related containers rules, the water's mires will sediment. In this study, with physical considerations, the potential capability of the pond to produce high quality water is proved. According to historical states of Choghazanbil site and archeology excavations; with combining two hypotheses, the real performance of two ponds is filtering discharged surface waters.

***Keywords*:** Choghazanbil ,small pond, water filtration, water pressure.

INTRODUCTION

Choghazanbil Ziggurat is the most important architectural works of Ilamids which recorded in Iran globally in 1871. This site is the valuable memorial of Ilam civilization which was constructed in the margin of Karkhe River in Khuzestan plain and near Susa city (Neghahban, 1994). This building (dimension:106×106 meters and 53 meters height) is a five-storey scalar form building and includes 5 concentric towers with different heights (at present 2.5 storey around 23 meters are remained).Considering valid data, Roman Girshman knew that Ziggurat Dorontash was constructed not in one step operation but in two steps (1960-1961). Figure 1(Majidzadeh, 1991)

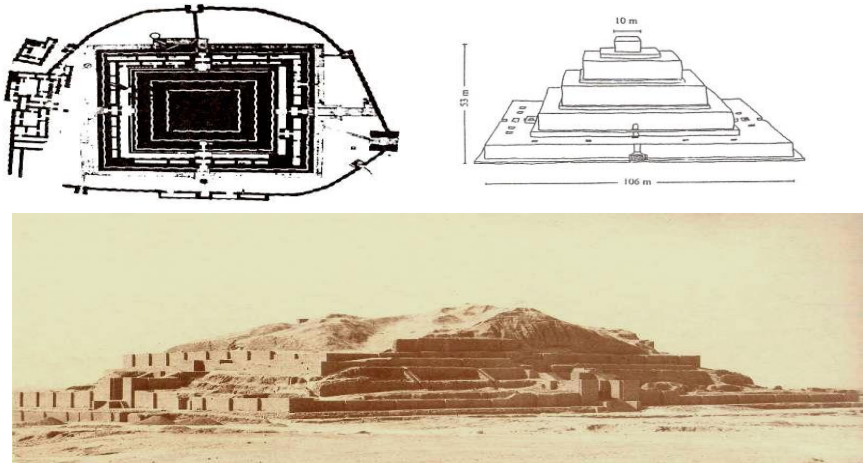

Figure 1. Choghazanbil Ziggurat near Susa (1250 B.C.)

One of the considerable parts of this collection is the existence of a small pond. According to Girshman dowsing, certainly it has refinery application. The purpose of the present study tries to apply two different fields of science like physics and fluid mechanics and architecture. Existence a guidance signboard in Choghazanbil provides the incentive of planning this study for us.(Figure 2) As it is seen in the following picture, two principal dowses are considered about the pond performance:

- 1- The filtration plant is planned by Prof. Roman Girshman
- 2- The possibility of gathering surface water which was planned by Dr. B Mofidi Nasrabadi from the counselors of this historical site. Figure 2 .(Mofidinasrabadi, 2007)

Figure 2. Guidance signboard in Choghazanbil near the main pound, in this signboard gathering surface water is mentioned as main role of the pond. It is written in Persian.

Dorontash city was discovered by air pictures which were provided for considering the oil areas of the district. The first excavations were conducted by Domaknom in 1935-1939 and 1946. Excavations and simultaneous protection of the big part of this collection were done in 1951-1962 by Roman Girshman- French archeologist and scholar. From that time to 1998, sporadic attempts were done for protection of all the constructions of this historical area specially Ziggurat (Girshman, 1995).

Water discharging hypothesis in Choghazanbil and small pond site

Existence of multiple drain pipes on the construction and sometimes the existence of canals for conducting water under the fences show that Ilamids also found the necessity of water protection system according to the quality of applied materials and the climate in that time. The difference of recognizing the surface water discharging system on the Ziggurat and the other site is that, with special architectural type, some drain pipes were planned to conduct water; But in the archeology surrounding, according to more spaces and natural ups and downs, water conducting and water movement were performed naturally (Amiet, 1998). This information increases the possibility of gathering surface waters of the pond.

Water filtration hypothesis in the pond

The water reservoir has 10.70 meters length, 7.25 meters width and 4.35 meters depth and its capacity is 350 cubic meter. The reservoir floor is covered by complete bricks. These bricks are attached to each other with plaster mortar and have special strength. Its two lateral walls are constructed with bricks and plaster. These walls are leaded to the ending wall of the reservoir which has been formed from the soil natural volume. The forth wall of the reservoir that is toward the city wall is constructed with sound bricks and plaster. This wall has 9 passage ways for water in its lower part (Figure 3). (Prada, Yousefzadeh, 1977)

Two rows of bricks and one row of stone are covered over each of these passage ways. All spaces and joints from the depth to stone rows were bitumen.

Figure 3. Main pond with 9 passage ways for water

The reservoir angles have curve-form with layer of plaster on it. All these nine water passage ways were located under the city fence wall and caused ascending the less mired water and filling it in the small pond of the other side of the wall. when the reservoir became full of water , the water that its mire is sediment and has necessary cleanliness and limpidity for consuming, passes from the canals with broken surfaces and fills the upper small pond (Abdi, 1994).

Physical considerations

Slowing ponds are agents for lowering a fluid energy under a cliff or a steep of a river or canal. This discussion is limited to cubic shape small ponds with horizontal floor, but sometimes the steeped floors are used to refrain from much excavation. Usually it is used in the pond entrance for creating wave in the flow. Overflow is a barrier that is put in the canal course and caused liquid gathering and then passed over or among it. With measuring the liquid level altitude before overflowing, the flow will be distinct. Overflows which are made from metal sheet or other materials so that the flow spouting leaps over it freely are called overflows with sharp crown. The other type of wide overflows carry the flow in widthwise direction.

In lieu of the distinct wet environment, the sectional surface of some of the canals is more effective than some canals in which there are more surfaces. Generally when a canal is built, foundation making and possibly priming should also be considered. By using Mening formula, it is observed that when the section surface is at the minimum, the wet environment has also the minimum amount, so foundation making and priming inclined to their minimum amount for the same canal dimensions. The best hydraulic section is the one that has the minimum wet environment or the minimum surface for that section (Streeter, 1997; White, 1986).

$$Q = \frac{C_m}{n} AR^{2/3} S^{1/2} \quad (1)$$

Q in terms of (L^3/s), A flow section surface, R radius and S line gradient, C_m energy level and n is roughness coefficient. We can write the equation as following with having Q and n:

$$A = cP^{2/5} \quad (2)$$

The best section level in cubic canals is half-width depth and this subject is independent of the section dimensions. It means, we can derive b=2y from Eq-2 for our special problem. (Figure 4)

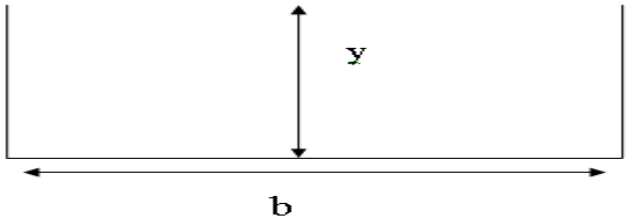

Figure 4. Best Relation between depth and width of pool

If we calculate effective depth as depth of pool minus depth of weir; it will be $y = 4.35 - 0.7 = 3.65$. If we compare it with the result of Eq-2; the result will be amazing, they are exactly equal in amount! $y = b/2$. It seems the designer of pool was well-informed about the mechanics of fluids.

According to physician's definition from P pressure, the F vertical power on the A section surface is called pressure. $P = \frac{F}{A}$ But about the liquids, this equation is as following:

$$P = \rho gh + P_0 \quad (3)$$

Which ρ is the liquid density, g is the land gravity in the place, h is the liquid altitude above the considered point and P_0 is the atmosphere pressure on the surface of liquids.

For a uniform flow with no friction, we can derive Bernoulli's Equation as: [9]

$$gz + \frac{V^2}{2} + \frac{P}{\rho} = cte \quad (4)$$

In figure 3, A and B points have the same pressure because of alignment i.e. P_A=P_B, but in C and D point these two points are not with the same pressure because of altitude differences.

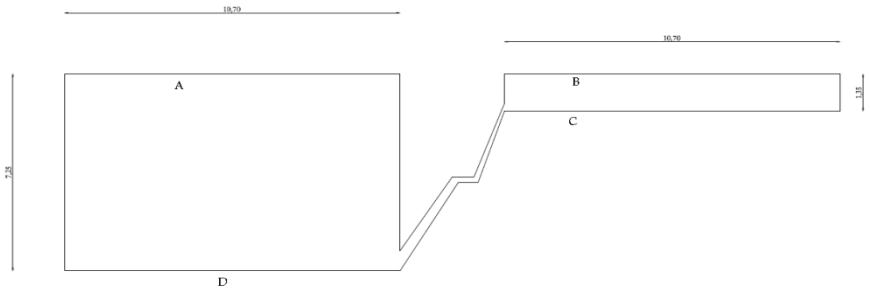

Figure 5. Linear section and the way of the ponds relations

If we suppose that passage ways are not connected to upper pond and the they are linked to out space then We can write Bernoulli's Equation for A , D points:

$$gH + 0 + \frac{P_1}{\rho} = 0 + \frac{V^2}{2} + \frac{P_2}{\rho}$$

So the velocity of water will be $V = \sqrt{2gH} = \sqrt{2 \times 9.8 \times 3.65} \approx 8.45 {}^{m}/_{s}$. In order to calculate Flow Rate of passageway, we can use Eq-5

$$Q = AV \qquad (5)$$

Which A is passageway interior area and V is Velocity. So Q for each way will be $8.45 \times 0.06 \cong 0.507 {}^{m^3}/_{s}$ According to our mechanics fluid knowledge, to achieve total Flow Rate tem with 9 parallel ways, we should sum all Flow Rates:

$$Q_1 = Q_1 + Q_2 + Q_3 + ...Q_9 = 9Q_1 \cong 4.56 {}^{m^3}/_{S}$$

Due to pressure difference, the above equation leaded to the fluid movement from point D to point C. This is a natural principle in physics that the system is willing to preserve its equilibrium state. And until there is pressure difference between two points, the fluid moves. During this movement, always the pressure of A and B points is preserved. So in the final state of the system in the considered agent, water movement from the bigger reservoir to the smaller one is possible from the existent pipes. According to the overflow width, with assumption controlling the entrance water Flow Rate, 350 cubic meters water are gathered behind the flood interrupter that its mire formed in a sediment due to being stagnant and then the water without mud enter to the upper pond.

CONCULSION

- In Girshman considerations, the connecting canals are stated for carrying water to the pond while this issue is not seen in Dr. Behzad Mofidi-Nasrabadi researches that it indicates the destruction of water transmission canal. So paying attention to half century differences of these two hypotheses is necessary.
- The present hydrology researches in the historical environment shows the Ilamid attention to surface water discharging.
- With conducted physical considerations, the potential capability of the pond for water filtration is proved quite practically;
- The necessity of building this pond and the existent altitude difference in two basic parts along with the relation of two parts by nine canals according to the complete adaptation of physical issues with the pond condition questioned the final discharging of the water lonely;
- In all, according to historical state of the Choghazanbil site and archeology excavations, between two existent hypotheses, we should know the discharging surface water filtration by the water agent as the right performance of this small pond by combining these two hypotheses.

REFERENCES

Neghahban E. 1994. Excavation in Haft Tappeh and Khuzestan Plain. Iranian Cultural heritage Organization Publications, Tehran.

Majidzadeh Y. 1991. Ilamid History7, University Publications ,Tehran.

Mofidinasrabadi B. 2007. Archäologische Ausgrabungen und Untersuchungen in Čoġā Zanbil, Münster.

Girshman R, Karimi A. 1995. Choghazanbil Ziggurat (Dorontash., Iranian Cultural heritage Organization Publications.

Amiet P, Bayani Sh. 1998. Ilamid History.Tehran University Publications.
Prada A, Yousefzadeh M. 1977. The Art of Ancient Iran.Tehran University Publication, Tehran.
Abdi K. 1994. Middle Ilamid Buildings, Tehran University Publication,Tehran.
Streeter VL, Benjamin E. 1997. Fluid Mechanics. McGraw-Hill Companies; 9 Sub edition.
White FM. 1986. Fluid Mechanics. McGraw Hill; 2nd edition.