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Water Conveyance System of Selinus

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Abstract**—** *Turkey is one of the foremost open air museums of the world with respect to historical water works. The Selinus water conveyance system is a newcomer of this museum. Selinus is located in Gazipaşa district. The remains include that of the aqueduct bridge and several stretches of rock-cut and/or masonry open canals. The total length of the water conveyance system, of which 700 meters is an aqueduct, is approximately 3.6 kilometers*.

Keywords**—** *Water Conveyance, Aqueduct Bridge, Selinus, Selinus Potamos*.

I. INTRODUCTION

The three substances necessary for human life are air, water and soil. With the transition from the Prehistoric age to the Neolithic age, the water need of the increasing population has also increased. They used existing water resources to meet their growing water needs.

Structures like well, cistern, water tank, springwater collection chamber, weir, dam, were used to collectand store water. Elements like pipes (terra cotta, stone, lead, wooden), open channel (earth, masonry), covered gallery, underground tunnel, pressure pipe inverted siphon or arched aqueduct-bridge to cross the valleys, were used in the conveyance and distribution.

Anatolia was at the crossroads of several civilizations during the last 4000 years, where a great variety of hydraulic structures were implemented, making Turkey one of the foremost open air museums of the World in thisrespect [12, 62, 66-68, 70, 71, 72].

Magnificent examples of water conveyance systems, dating back to the early centuries of the Ist Millenium A.D. are encountered in Turkey. Among these systems, special interest deserve those of İstanbul [20, 21, 22], Parion [42, 43]; Pergamon [28, 29, 33-35]; Troia [41]; Phocea [10, 59]; İzmir [27, 58, 64, 74]; Ephesus [32, 46, 63, 69, 78-83]; Aphrodisias [19, 24]; Alabanda [5, 60, 61]; Laodicea [8, 9, 76, 77]; Mylasa [2,3]; Patara [7,11, 37]; Antiochia ad Pisidia [13,14]; Perge [6, 15, 16]; Aspendos [15, 16, 44, 45, 47, 54]; Side [15, 36, 38]; Elaiussa Sebaste, Olba, and Diocaesarea (all three in in Lamas basin) [4, 21, 40, 51-53, 55-57]; Antiochia ad Orontes [25, 48, 73]; Samosata [39, 62]; Amaseia [50]; Ankara [31].

Compared to these renowned historical water conveyances, that of Selinus is rather a very modest, but charming example added to the distinguished open air museum of ancient water works in Turkey.

II. LOCATION

Selinus water conveyance system is located 177 km to the east of the province center Antalya, crossing the Selinus Potamos creek. The system supplied water to the antique city Selinus, located east of Gazipaşa district, and has been constructed in 630 B.C.

III. REMAINS OF WATER WORKS

The layout of conveyance system is given in Fig. 1. The spring, named Ilıca, (Fig. 2; Ilıca spring on Fig. 1), where the water was collected, has been preserved because it is still used today. Since the water conveyance system remained in the Gazipaşa settlement, it suffered a lot of damage. Therefore, the amount of residue that could be found was limited. However, other sections of the pass have disappeared due to settlement and agriculture. The aqueduct section, located at a section of about 700 meters before the reservoir, has also been severely damaged (Fig. 3). The chamber at the end of the system is in a similar situation (Fig. 4).

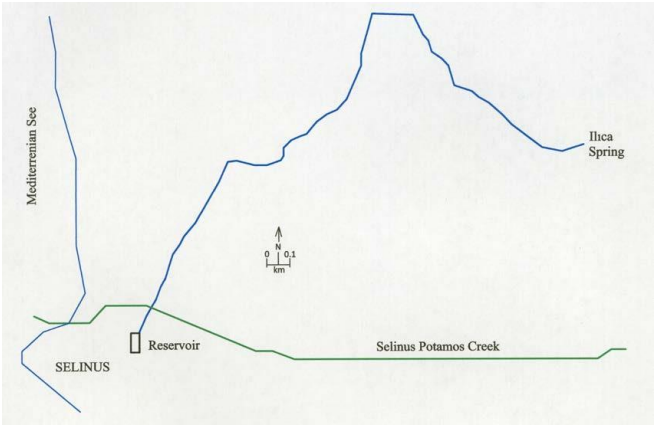

Figure 1: Ancient water conveyances to Selinus.

Figure 2: Ilıca spring

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Figure 3: Remains of aqueduct bridge

Figure 4: Reservoir

IV. Hydraulic Capacity Under Free-Flow Conditions

The conduits of ancient water conveyance systems are generally baked clay pipes, rock-cut or cut-and-cover masonry galleries and tunnels. The water is usually carried under free-flow conditions, yet, in certain pipe systems, it sometimes flows under pressure.

An analysis of the system for free-flow conditions, i.e., open-channel flow induced by gravity [16, 17, 30, 49, 69, 75] is based on the Manning equation (called also Gauckler-Manning-Strickler equation) for uniform flow. The equation is derived from the Brahms-Chézy formula and introduces a friction factor as a function of the hydraulic radius:

$$v = (1/n).R^{2/3}.J^{1/2} \quad (1)$$

In this equation, v is the mean flow velocity (m/s), n is the Manning roughness coefficient, R is the hydraulic radius (m) of the wet cross-section, and J is the energy gradient practically equal to the slope of the conduit. The hydraulic radius is the ratio of the wet cross-section area A (m^2) to the total length of the wet contours (m).

Introducing discharge Q (m^3/s) as the product of the velocity and of the wet cross-section (Q = v.A), the Manning equation can be developed as:

$$Q = (1/n).A.R^{2/3}.J^{1/2} \quad (2)$$

The flow regime related to a certain water depth in a conduit of prismatic shape is evaluated through comparison with the critical depth for the given conditions. This comparison is based on the following equation:

$$A^3/B = \alpha.Q^2/g \quad (3)$$

in which B (m) is the width of the water surface, α is the energy correction factor, and g is the gravitational acceleration (m/s^2).

The water depth resulting in the equality of both sides of the equation is the critical depth. If the left hand side is larger, the regime is subcritical. If the right hand side is larger, the regime is supercritical; and any increase in hydraulic losses may cause a hydraulic jump and a sudden increase in water depth, eventually creating problems.

V. Hydraulic Capacity of the Water Conveyance System

Since the water transmission system remained in the Gazipaşa settlement, it suffered a lot of damage. For this reason, it could not be determined whether the water was transmitted through open channels or terracottapipes. As a result, it was not possible to determine the amount of water that could be delivered. By making an assumption, it has been determined that 7 lt/sec of water can be transmitted with a 20 cm diameter terracotta pipe (full filled with free surface flow) and the average slope of the system is 0.008.

VI. Conclusion

The ancient water conveyance to Selinus, east of Gazipaşa, is roughly 3.6 km length, with a capacity exceeding 7 lt/s. It constitutes a newly discovered element of the large open-air hydraulic structures museum formed by Turkey.

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