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Irrigation of infrastructure projects of Egnatia Motorway: Implementation study of irrigation network of K4 Interchange

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Abstract

Abstract: - The large construction projects cause inevitable negative impact on the natural landscape of the exposed areas. Among these is the creation of disturbed surfaces with unsuitable soil material and gradients that imply the destruction of existing vegetation. On these surfaces the revegetation becomes both necessary and difficult. In the Egnatia Motorway and its vertical axes case where the highway passes through rich areas of endemic flora and unique natural beauty, the restoration and aesthetic improvement of disturbed slopes is significant. It requires the use of native plant species of the local flora, which will be integrated into the natural landscape and adapted better with a minimum of maintenance requirements on local soil conditions and irrigation network for the optimal plant growth. The case of K4 interchange in Thessaloniki is the practical application of measures that EGNATIA ODOS S.A. has designated for rehabilitation and aesthetic improvement of the urban landscape. The success of these projects largely is based on premium designed and well-constructed drip irrigation network.

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Key-Words: Irrigation network, plant growth, Urban Landscape, endemic plants, Landscape restoration

1. Introduction

Egnatia odos is the largest-scale public work ever constructed in Greece and one of the largest-scale in Europe. This great construction, introduced a new environmental strategy and a new perception of highway construction and

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protection of the natural and manmade environments by implementing innovative measures for protection and landscape restoration. Completed specialized landscape restoration studies with innovative planting methods using endemic plants. Basic condition for the well establishment of plants to the planting areas is drip irrigation through the establishment of permanent water pipe distribution network. The modern systems of water distribution for plants irrigation in large – scale highways projects due to the high water saving offer have established as the most efficient and easier to use with multiple economic benefits for both the user and for the country's economy general. These systems are consisted by various diameters of water distribution pipes and components for controlling protection and water supply network irrigation. The case of K4 interchange in Thessaloniki is the practical application of measures that EGNATIA ODOS S.A. has designated for rehabilitation and aesthetic improvement of the urban landscape. The success of these projects largely is based on premium designed and well-constructed closed water distribution pipe network with drip irrigation.

Fig. 1 K4 interchange-Planting Area

2. Matterials and Methods

2.1. Definitions

Network: From hydraulic point of view the network is a system of water distribution pipes. There are different types of network such as:
Distribution network: System of pipes that receive water from a small number of sources (entry points) and lead it to multiple destination points (exit points).
Branched network: Were supplied from a single point (head) which is formed by closed pipes routes (loops). Each outlet point is supplied via a single route.
Looped network: Where is supplied by one or more points which is formed by closed pipes routes. At each point lead more than one routes starting one of the heads of the network.
Flow rate or capacity: Is the mass/weight or volume of a fluid moving in a given time. The irrigation networks are classic examples of solenoid flow by flowing under pressure, i.e. the fluid in the pipes. The solenoid flow definition is identical to the term one dimensional flow which analyzed only in one dimension.
Permanent Flow: occurs when the flow and hence the velocity at a given cross section remains steady and invariant to the time. (but can vary with position). Divided into permanent uniform flow (uniform velocity along of flow line) and permanent non-uniform flow (changes of pipes diameter etc.)
Non-permanent flow: called the flow wherein the flow rate is a function of time i.e. Q = Q (t), i.e. unsteady flow occurs when the velocity is changed at all points in time. Depending on the flow velocity, flow and we can see two types:
Streamline flow: This type of flow displayed in prices of dimensionless Reynolds number less than 2320. Turbulent flow occurs when values of the Reynolds number are larger. In practice it is possible to achieve streamline flow in a pipe with Reynolds numbers up to 10000. The flow, however, is highly (hydrodynamic) unstable and even the slightest disturbance (such as a flick of the pipe) will turn immediately to turbulent.
Flow velocity: Important factor in water distribution systems designing. All hydraulic calculations in closed water distribution networks have the needed admission that the flow is stable and only then apply.
Flow rate: The volume of water that passes from a cross section in the unit of time. Namely the flow rate of a pipe in any position is equal to the product of cross-sectional area and the velocity of the fluid at that position. Along of a

pipe the flow maintained stable in the case of variable – pipe cross - section. Namely Q constant (equation is called continuity equation and is a direct result of the matter conservation). From the above arises that along of a pipe with variable cross – section the fluid velocity is not the same everywhere. In places where the pipe narrows the flow velocity is bigger.

Pressure: Is the force that affects per unit area or surface. Particularly in the water case pressure is the force that generates a point or an area of the water above it i.e. the weight of the overlying water column. Because the weight it receives a point or a region is a function of the height of the water column, measured either in meters or weight. It is important to know that no liquid contains any internal force. The water movement happens only from a higher pressure region to a lower.

Static pressure: The pressure at a point where there is no flow.

Operating pressure (Dynamic pressure): The pressure at a point of a network where a given amount of water (flow) moving in it.

Density: The relationship between the fluid mass and its volume. The unit for density is defined as the mass (kg) contained in a fixed volume (m3) and is kg / m^3.

Specific gravity: The ratio of the fluid density in relation to that of the water, the water has a specific gravity equal to 1.

Viscosity: Called the fluid resistance to flow.

Pipe roughness: The roughness is measured in mm (absolute) or relative to its diameter. It derogating measure of actual pipe wall than the ideal. In streamline flow the affect is insignificant. Main reason for the pressure drop due to the roughness is the pressure forces that occur when the fluid flowing over the protrusions formed dead spaces in the recesses. The typical values of roughness for trade pipes are shown below.

Table 1 Values of pipes roughness ks

Pipe type	Equivalent roughness ks
PVC or HDPE (plastic)	0.1 mm (0.0001m)
Cast iron pipes	0.25mm (0.00025)
Steel pipes	1.00mm (0.001m)

In practice, because a pipes network is designed for many years of use (30-50 years), the maximum energy losses in pipes must be calculated for the lifetime of the network. The quality of water and the pipes material creates salts deposition conditions in the internal surface thereby reduce the discharge capacity of pipes over time due to increase or decrease the cross – section roughness. This process causes the ' “pipes aging”, i.e. causes increasing line losses with the passage of time. For this reason, in the case of borderline assessments (e.g. poor quality irrigation water) suggested to use relative roughness of not less than 1 mm (0.001m), for each type of pipe.

2.2. General description - Location of the study area

The implementation study of K4 irrigation network Egnatia Odos, used the R_plan (horizontal plan) and L_section (Longitudinal section) drawings of highway project, the approved planting study of K4 interchange and its influence zones was based on spot investigation and prepared in accordance with the technical specifications of the Egnatia Odos SA. Moreover an objective was that the different combination of parameters and limitations to have the minimum cost pipe the correct plants irrigation and finally the road safety. The location of implementation study of irrigation network and endemic plants installation included the influence zone of Interchange K4 in Ch. 12+500, part of connecting road K4-K5, Ch. 12+500-15+500 and Interchange Girokomio total length 5.9 km. The entire study area is located in the north-eastern part of the northern city of Thessaloniki in Central Macedonia.

2.3. Water Resources and Soil characteristics

The water supply for irrigation of the above areas secured by standby of water transportation main pipe from pumping station at a distance of about 2500 km from the beginning of the K4 influence zone. The values of pressure and flow characteristics of the network were estimated at 8.4 atm. and 19m3 / h respectively. These attributes were within acceptable operating limits of the pumping station.

From the analysis of soil data showed sufficient uniformity and homogeneity in all surfaces. Generally assumed the drainage conditions of embankments are satisfactory. After these selected drip irrigation method limited duration to reduce the surface runoff.

2.4. Plant water needs and Irrigation method and water budget of plants area

The prevailing views on the plants requirements in water based on theoretical and experimental data accept that the daily average in water needs of most plants ranges from 4mm / day to 6mm / day depending on the plant species, the soil type and microclimate which depends on the highway characteristics project.

For the possibility of plants systematic irrigation for complete satisfaction of their water needs as well as for achieving greater uniformity and water saving chosen drip irrigation method with dripper flow 4 litters / hour per plant. With drip irrigation system efficiency equal to 0.95 and a daily water demand 1.5 litters per plant the daily water amount per plant is estimated at 1.57 litters. Calculating the soil volume corresponding to the active root zone of the plant is 0,036 m3, and one third of this volume is available water to plants and from this 60% is beneficial moisture than the irrigation range calculated in 5 days.

2.5. Water Distribution network arrangement

Generally a water distribution network for irrigation substantially is a pipeline pressure system receiving water from a source (water abstraction), and transports it through them with the required pressure and flow, in the needed time, the area or areas to be applied. The arrangement of Water distribution network for irrigation of K4 interchange and its influence zones relates to Branched network operating under pressure and comprises: The pumping station ensuring the required flow rate and network operating pressure, the pipes network transporting water from the pumping station to the irrigation boundaries of K4 interchange and the surrounding areas the individual hydrants at the boundaries of irrigation Areas and finally the receiving and transporting water pipes from hydrants to drip lines of irrigated areas.

2.6. Functional requirements of the irrigation network and Design of the Network

The basic functional requirements taken into account in the design of water distribution network for irrigation related both to ensure the required flow at any point of irrigation network secondly maintaining pressure within acceptable limits, and the equation in some cases between flow and irrigation consumption. In particular:

a) Ensuring at each point in the network adequate flow with sufficient water velocity as possible to the boundary between 0.5-1.5 m/sec.
b) Ensuring at water distribution and application pipes adequate pressure to satisfy normality in irrigation operation.
c) Limitation the maximum pressure for network protection.
d) Air Exportation from main lines and drip lines and tertiary irrigation network (drip line network)
e) Network protection of water hummer.

In the implementation study of irrigation network of K4 interchange and its influence zones taken into account the area morphology, the longitudinally gradients of distribution pipes the altitude differences among various network positions the shape of the intarchange and irrigation areas and finally the arrangement and the needs of irrigated areas.

2.7. Hydraulic calculations

In a closed pipeline system friction forces developed as a result of water and molecules contact. In other words the water energy reduction that occurs in a closed pipes system due to friction forces between the water molecules and the wall of the tube is called the pressure loss due to friction.

The level of these losses is a function of water velocity V, the water density p, the water kinematic viscosity ν, the pipe diameter D and its wall roughness. In hydraulic applications energy prices have units of length therefore the friction losses are expressed in the same units (meters of length) so are also called linear losses.

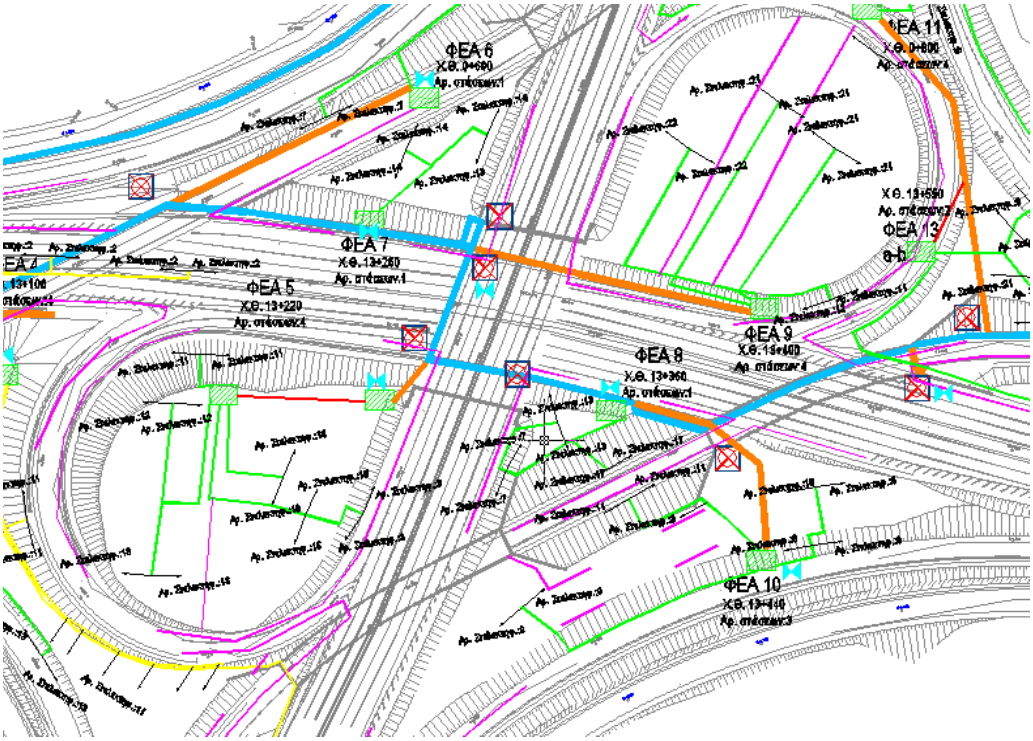

Fig. 2 K4 interchange - Schematic arrangement of the water distribution network

For the energy losses calculation in pressure pipes have developed different equations the best known of which are: Darcy – Weisbach, Colebrook – White and Haazen – Williams equations.

The hydraulic calculations for pipe irrigation network K4 interchange and its influence zones were taking the view of streamline flow in closed pipes yielding the linear height loss hf, as a function of a coefficient of friction f. For this reason used the Darcy – Weisbach equation applicable for streamline and turbulent flow. In the present case the flow is turbulent (Re> 4000) and in many cases fully turbulent (Re> 6000). For this reason, the friction factor f calculated by the semi-empirical Colebrook - White formula. Solving of Darcy – Weisbach equation becomes difficult because the Colebrook – White equation is the interlace F function thus requiring iterative solutions. This is a time consuming process especially in large networks such as the study area. In order to overcome this difficulty and to quickly calculation of the friction coefficient F used a specially MS - EXCEL spreadsheet.

Water hammer term characterizes overpressure phenomena corresponding to unsteady flow. The water hammer caused by overpressure generated to water distributions networks to any flow changes. It occurs with:

- starting and stopping pumps
- flow change by valve closing
- air pockets presence in the network
- stopping various gates during irrigation
- pipe breakage

The sudden flow change due to the above factors increases or decreases the water velocity values. Practically this translated by transfer suppression and depression wave. This phenomenon continues until the reduction of these strong forces. The time lasts for wave transfer is determined by network length, material and pipe diameter, flow and ground inclination. To calculate the propagation of suppression and depression waves we used the Allievi formula:

$$\alpha = \surd g/\varepsilon(1/E\nu+1/E\sigma \cdot d/s \cdot c) \qquad (1)$$

where: G the gravity acceleration (9,81 m/sec^2); Eν the water elastic modulus (2,1X108 kg/m^2); Eσ.the pipe elastic modulus (for PVC 3X1X108 kg/m^2); ε the pecific weight of water at a temperature of 5°C (1000 kg/m^3); s the pıpe wall thickness (m); d the internal diameter of pipe (m) and c a factor depending on the Poisson ratio. In the case of PE pipes is 0.4.

The time lasts for transfer suppression and depression wave, is given by:

$$T\kappa=2\cdot L/a \qquad (2)$$

where: α the velocity propagation of surpression and depression wave and L the pipe length

<u>We distinguish the following cases:</u>

1) Flow closing time of the valve be less than the velocity propagation of wave i.e. T<2L/α

In this case the suppression was calculated from the f Joukowsky formula:

$$\Delta\rho=\alpha\cdot\Delta V/g \qquad (3)$$

where ΔV: the velocity change and the surpession height depends on the characteristics and pipe material (diameter, wall thikness, pipe elastic modulus).

2) Flow closing time be grater than the velocity propagation of wave

In this case the surpression depends only on the pipe length was calculated by Micheud-Marchetti formula:

$$\Delta\rho=2\ L/\ g\cdot\Delta V/T \qquad (4)$$

Generally the air presence in the network under shortage conditions of flow helps to accumulate air pockets at the highest points of pipes preventing the flow. In normal flow conditions the air pockets are moved of the highest point to the lowest resulting the movement of large amounts of water causing changes in water flow rate and consequently the creation of local surpression phenomena.

Due to the very low water compressibility may be caused uncontrolled air accumulation in a network. In the case of pipeline breakage the released air energy is multiple of water energy of the water resulting serious risks for both the network parts and to the lives of people. Finally, the air existence in networks can create data reading problems on flow organs and accelerate their deterioration. For control the problems of air presence in closed pipes nework of K4 interchange and its influence zones used various control devices (air valves).

To control the problems of air presence in irrigation network of K4 intarchange used various control devices (air valves). The air valves other times can release the small air quantities dissolved in the pipe when the network is under pressure (automatic air valves), other times export large amounts of air during the filling and introduce large amounts of air during the network evacuation (kinetic air valves) and other times fulfilled the three functions by the using of one valve (double acting air valves).

2.8. Solving methodology of K4 area irrigation network

As mentioned above, the water distribution networks for irrigation are classified as branched networks, i.e. networks where there is a central distribution pipe (main pipe) and secondary pipes resulting in sub hydrants. In solving the present irrigation network this was seen as a conceptual system, while the network points with water inputs and outputs or change geometry or pipes characteristics changes or the various box valves positions for irrigation control named nodes. Each transfer water element in length L called branch. It should be noted that because there is no only one solution of a distribution network and performed by different combinations of its hydraulic parameters such as pipes diameters, flow and piezometric load, it is obvious that different solutions resulting from different combinations led to varying installation cost. In other words, in solving of presence network selected the optimal formulation of mathematical methods referred to the hydraulic operation of network components and the effectiveness cost analysis for its solving i.e. as a function of the installation cost and effectiveness which they represent. Basic components of the water distribution network for the irrigation areas of interchange network and its influence zones was pressure control projects (pressure regulators), water distribution network projects (water pipes) and various flow regulating devices (flow regulator valves). In cost terms the main contribution in network cost installation related the water pipes. So for the calculation of their diameter, the data were taken into account are:

- The position of water intake and its position altitude
- The available flow rate of water intake
- The network designing i.e. the pipes routing and points altitudes and the box valve positions
- The minimum piezometric load resulting from the box valve operation
- The required piezometric load at the beginning of the network
- Flow rate in every branch of network

The flow calculation in every branch become in accordance with the landscape restoration study and finalized the plants water needs and the operational limits of tertiary irrigation network. The tertiary irrigation network requirements were taken into account in total piezometric load calculating at the network beginning. Based on the above data was not considered necessary to secure second water intake for irrigation of K4 planting areas. During the pipes dimensioning process of water transportation network taken into account that the selection of smaller pipe diameter would imply lower costs related to another pipe installation with larger diameter. But the choice reduced diameter would increase the flow velocity. Higher flow velocity would imply biggest risks of water hummers and pipes or network equipment breakages bringing additional costs for repairing damages. In the pipe diameter calculating the flow velocity height obtained between the limits 0.5-1.5 m / sec while the pipe resistance in pressure was increased in order to exceeded the overpressure height due to water hammer.

So based on the above determined operation pressure requirements for each box valve, considering demand flow shared equally at the beginning and end of the branches. The Hydraulic grade line of tertiary irrigation network etched so that upon diameters selection takes into consideration their class. In this phase, we calculated the energy requirements at the network entrance i.e., the piezometric load in order to known the pressure limitations. For safety reasons the required piezometric load for most of the box valves was estimated at 20 m. (2 atm). Exception was made to those were greater requirements and estimated at 25m (2.5atm). So starting from water receiving and having known the figures and requirements of Box Valves (B.V.) estimated losses of network branches to the most remote and unfavorable points of it while adding to these or removed the altitude difference from the receiving water. The result was the entrance piezometric load of the network which calculated at 84 m (8.4 atm). More specifically: Based on the B.V requirements determined the branches flow of the network. The calculations started from the tertiary irrigation network resulting at the end the central pipe flow marching from downstream to upstream. Based on the branches flow determined the minimum pipe diameter and class criterion satisfying the flow velocity (0.5-1.5 m / sec) and satisfaction the network pressure resistance. It was checked if the created pressure satisfies the above velocity limitations and the resistance of the selected pipe diameter to water hummer. Each time the energy calculation starting from the water receiving point (standby position of connection K4 interchange with irrigation pipe previous contracting) considering the altitude position. From this point, we estimated the losses to the first B.V. In losses were added the pressure requirements of B.V and the difference altitude between the two positions. If the pressure of each branch was different than the allowable a new diameter was selected and calculations repeated. This check was made for all positions of B.V and ended when checked all B.V positions to the mentioned restrictions i.e., velocity, pressure, overpressure. Finally etched the hydraulic grade line of the network and thus was made known the entrance piezometric load of each B.V.

3. Results

The results of the calculations relating to the main pipes diameters selection are shown in the following tables. At this point we should emphasize the importance of optimal diameter selection satisfying criterion of velocity limitations on the (0,5-1,5 m / sec) and satisfaction pressure resistance of the network. Furthermore important factor for the acceptable diameter is the investigation of water hummer risk on the whole length of main pipe. Finally chosen main irrigation pipe with nominal diameter Ǿ 125 and pressure resistance 10 atm. Main irrigation pipe with nominal diameter Ǿ 110 excluded because water hummer calculations shown high risk of pipe breakage from created overpressure. The tables below show the calculations about mains irrigation pipes at each B.V and their energy requirements. It is noted that in total energy requirements of each B.V position including 10% due to loss of its specific components. The maximum energy requirements of the network were found at 4N B.V position. In one case (PE Ó125/10ATM) the maximum value is equal to 83.11 m or 8.4 atm and in the other (PE Ó110/10ATM) is 89,28 m or 8,93 atm. In both cases the maximum network flow is 19 m^3 / h and divided throughout the length both to avoid overpressures other satisfying the plants irrigation program. These data used for the water hummer calculations in different times Tx=1 and 10 sec of closing valve for the two main pipe diameters (PE Ó125/10ATM-PE Ó110/10ATM). For the case of main pipe PE Ó 125 10/ATM and for flow of 19 m^3 / h and closing time of valve Tx=1sec the generated overpressure exceeds the nominal resistance of the pipe especially at the first 1430 m of its length. Practical this time corresponds only in power outage case. In closing time of valve Tx=10 sec. the risk of water hummer due overpressure reduced within the pipe nominal resistance limits. Closing time of valve equal to 10 sec applied to all irrigation networks in highways projects thus to avoid the water hummer damages. Water hummer calculations for main pipe with nominal diameter PE Ø110 10ATM showed that even with a closing time of valve Tx= 30 sec the generated overpressure exceeds its nominal resistance at 1.4 atm. Further phenomenon investigation showed that the risk of water hummer avoided in closing time of valve Tx=190 sec i.e., about 3.1 minutes. In practical terms this time is too large and valve installation for water hummer treats would result the continuous opening and closing valve with further of problems in plants irrigation. For these reasons the pipe with nominal diameter PE Ø110 10ATM was rejected and finally chosen the pipe PE Ø125 10ATM. Hydraulic calculation results also showed that the pipe section to the Girokomio interchange for position 1GIR could be chosen smaller diameter i.e. PE Ø110 10ATM instead of PE Ø125 10ATM. The high of energy losses, the large altitude difference, the satisfaction of plants in water needs during peak season, which the irrigation range is relatively small, but also the road safety led our selection in larger pipe diameter for low levels of network pressure operation in order to achieved timely and effective irrigation both for plants and road safety. The network piezometric line etched based on the pipe diameter calculations. The following figures show network piezometric line to be known entrance piezometric load at each B.V.

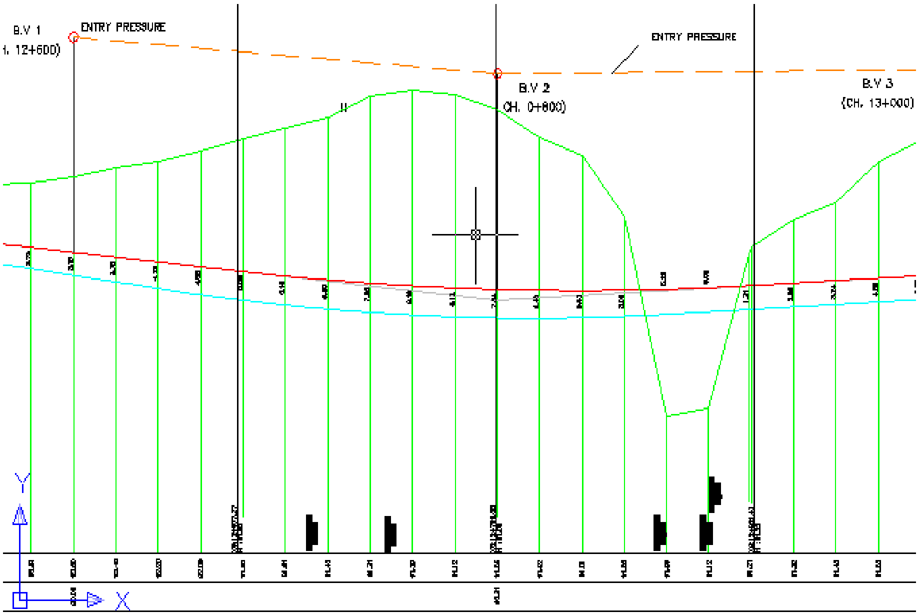

Fig. 3 Sample network piezometric line

Air Box Valves placed in inclinations of main network pipe, after pressure regulating devices, to main pipe diameter changes, to its passes of over the various structures of K4 interchange generally in the highest points of the main pipe routing and every 500 meters across of its large length. Box valves for water evacuation were placed at the lowest points of the pipe route close technical culverts for pipe evacuation in case of damage restoration or during the period which the network is closed for a long time (winter period). Pressure reducing valve boxes were placed at the beginning of the network at the connection point of main network pipe to reduce and maintain the operating pressure at the desired limits. The pressure at that point was 10 atm. The regulator valves reduce the pressure to 8.4 atm. The selection of BV positions for the irrigation control of each irrigated area was based on required flow, ground inclination, the area particularity and the losses coverage of network pressure. Where considered necessary inside within them pressure regulators were installed.

The network main pipe route was designed so that in one hand were appropriate to follow the left verge of highway on the other to achieved the optimal use of existing K4 interchange structures. The choice for any kinds of B.V. (irrigation control valve box, Pressure reducing box valve, Air Box Valve, Water evacuation box valve) position took that place for the reasons mentioned above. In addition to network protection and treatment of water hummer and for its treatment placed discharging box valve adjusted to a pressure 5% relative to the maximum static of the installation position. The weekly irrigation schedule of K4 interchange and its influence zones adjusted to the required irrigation range of plants during the peak months of summer (Table 2).

Table 2 Weekly irrigation schedule during peak periods of summer

	First day	Second day	Third day	Forth day	Fifth day
5-8 a.m	K 4 : B.V. 4a, 4b and G/INT : B.V. 1β	K 4 : B.V. 7, 8 και G/INT. : B.V. 4a	K 4 : B.V. 11c, 11d and GIR/INT. : B.V. 6β	K 4 : B.V. 2N and GIR/INT. : B.V 7	K 4 : B.V.1, 2, 3 and GIR/INT. : B.V 1α
8-11 a.m.	K 4 : B.V. 4c, 4d and G /INT. : B.V. 2a	K 4 : B.V. 9a, 9b και GIR/INT. : B.V. 4b	K 4 : B.V.13, 14 and GIR/INT. : B.V. 6c	K 4 : B.V. 3N and GIR/INT. : B.V 7d	K 4 : B.V. 5δ, 6 and GIR/INT. : B.V 3β
11 a.m. - 2 p.m.	K 4 :B.V. 4e, 5a and G/INT. : B.V. 2a	K 4 : B.V 9c, 9d και GIR/INT. : B.V 5a	K 4 : B.V.15, 16 and GIR/INT. : B.V. 7α	K 4 : B.V. 4N and GIR/INT. : ΦΕΑ 8a	K 4 : B.V. 11α, 11β and GIR/INT. : B.V 6α
2-5 p.m.	K 4 : B.V.5b, 5c and G/INT. : B.V 3a	K 4 : B.V. 10a, 10b και INT GIR . : B.V. 5b	K 4 : B.V. 17, 18 and GIR/INT. : B.V. 7b	K 4 : B.V. 12 and GIR/INT. : B.V 8b	K 4 : B.V. 1N and GIR/INT. : B.V 7γ
5-8 p.m.	G/INT : B.V. 8c	GIR/INT. : B.V 8d			

4. Conclusions – Discussion

The case of K4 interchange in Thessaloniki is the practical application of measures that EGNATIA ODOS S.A. has designated for rehabilitation and aesthetic improvement of the urban landscape. The success of these projects largely is based on premium designed and well-constructed closed water pipe distribution network with drip irrigation. The K4 irrigation network classified as branched network, i.e. Network where there is a main distribution pipe and secondary pipes resulting in sub hydrants. In solving of presence network selected the optimal formulation of mathematical methods referred to the hydraulic operation of network components and the effectiveness cost analysis for its solving i.e. as a function of the installation cost and effectiveness which they represent. Basic components of the pipe distribution network for the irrigation areas of K4 interchange network and its influence zones was pressure control projects (pressure regulators), pipe distribution network projects (water pipes) and various flow regulating devices (flow regulator valves). In cost terms the main contribution in network cost installation related the water pipes. During the pipes dimensioning process of pipe distribution network taken into account that the selection of smaller pipe diameter would imply lower costs related to another pipe installation with larger diameter. But the choice reduced diameter would increase the flow velocity. Higher flow velocity would imply biggest risks of water hummers and pipes or network equipment breakages bringing additional costs for repairing damages. In the pipe diameter estimating the height of flow velocity obtained between the limits 0,5-1,5 m / sec while the pipe resistance in pressure was increased in order to exceeded the overpressure height due to water hammer. Based on the B.V requirements determined the branches flow of the network. The calculations started from the tertiary irrigation network resulting at the end the central pipe flow marching from downstream to upstream. Based on the branches flow determined the minimum pipe diameter and class criterion satisfying the flow velocity (0,5-1,5 m / sec) and satisfaction the network pressure resistance. Checked if the created pressure satisfies the above velocity limitations and the resistance of the selected pipe diameter to water hummer. Each time the energy calculation starting from the water receiving point (standby position of connection K4 interchange with irrigation pipe previous contracting) considering the altitude position. From this point, estimated the losses to the first B.V. In losses were added the pressure requirements of B.V and the difference altitude between the two positions. If each branch pressure was greater or less than the allowable selected new diameter and calculations repeated. This check was made for all positions of B.V and ended when checked all B.V positions to the mentioned restrictions i.e., velocity, pressure, overpressure. Finally etched the hydraulic grade line of the network and thus was made known the entrance piezometric load of each B.V.

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