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RESEARCH ARTICLE

REHABILITATION AND OPTIMIZATION OF THE WATER SUPPLY DISTRIBUTION NETWORK OF DURRËS-ALBANIA

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Abstract

The condition of the water supply and the actual functioning of the distribution network in Durres area are inadequate to sustain demand at an acceptable level of service for all the billing zones. The distribution network of Durres city is fed at one point (Xhafzotaj junction) for 300-350 l/s with an elevation of about 50 m asl. The planned new transmission line has a diameter of 700 mm and will bring extra 630 l/s. The water distribution systems are one of the vital urban infrastructures and their operation with a high level of service are of high importance. Many phenomena in water supply systems such as leakage, breakage of pipes etc. are a function of pressure. When pressure dependency of demand is considered in the hydraulic analysis, the results thereof shall be consistent with reality. This article presents the new design methodology for a good optimization of the distribution network. The distribution network has been reconstructed as a ring network. It is planned to build 6 DMA's (District Metered Area) to control the flow, pressure and consumption in DMA to build the Water Balance.

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Introduction:-

Water distribution systems (WDSs) are one of the major infrastructure assets of the society, with new systems being continually developed reflecting the population growth, and existing systems being upgraded and extended due to raising water demands. Designing economically effective WDSs is a complex task, which involves solving a large number of simultaneous nonlinear network equations, and at the same time, optimising sizes, locations, and operational statuses of network components such as pipes, pumps, tanks and valves. This task becomes even more complex when the optimisation problem involves a larger number of requirements for the designed system to comply with (e.g., water quality), includes additional objectives beside a least-cost economic measure (e.g., potential fire damage) and incorporates more real-life aspects (e.g., uncertainty, staging of construction). The area is partially supplied with water from the existing network which was originally built in the 20s by the Italians who have built warehouse No. 1. In the later years until the '90s the network was expanded according to the planned urban development. After the 90s, the way of development and the intensity of development changed in time, height and territory, creating problems in the existing water supply districts which are not designed for the new norms and requirements for drinking water supply. It has been 30 years since the change of the system and in the distribution network partial reconstructions have been made without giving a final solution to the 24-hour water supply of the whole city.

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Currently in the city the capacities of water depots do not meet the need for 24-hour water supply and maximum consumption. In the area of the former chemical warehouse, the existing tank is out of order, failing to supply the surrounding area which is far from the tank area 2 and 2/1. The tank were built before the '90s with prefabricated structures which have a lifespan of approximately 50 years which do not meet current design standards. These depots also have filtrations which pollute the quality of the water that accumulates by reducing the quality of the water.

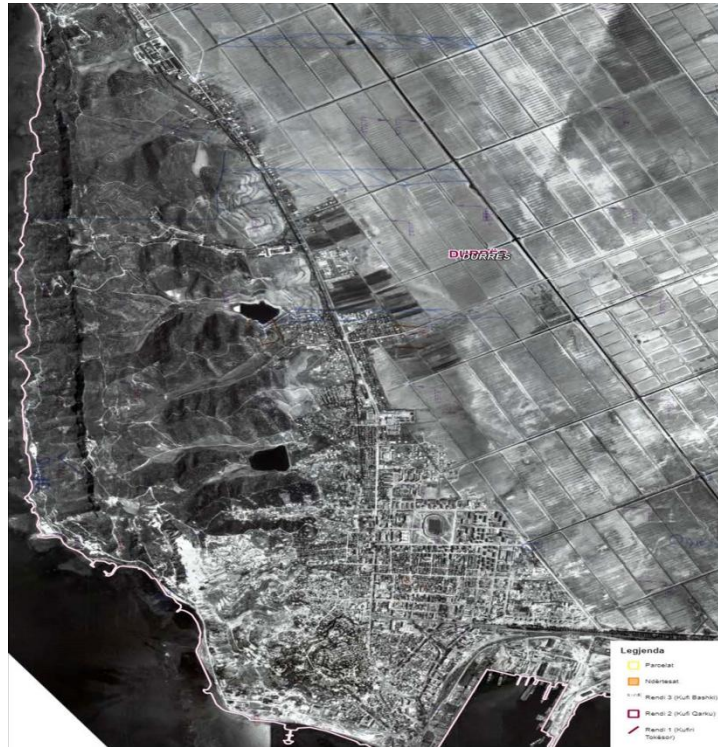


Fig.1:- Orto photo since 1990.



Fig.2:- Expansion of the city Orto photo 20.

Existing condition of water supply

The problem of guaranteeing the quantity of water, to cover the inhabited areas both quantitatively and qualitatively after the '90s, is well known. There are few areas that have solved this problem for 24-hour drinking water supply per day. This situation comes not because of the lack of water in our natural resources, but as a consequence of some factors, the most important of which are those presented below:

1. Increased need for water after the '90s with the use of new household appliances.
2. Depreciation of existing networks built before the 1990s.
3. The demographic movement towards cities has been very high
4. Placement of residents in unplanned areas in which there is a lack of engineering infrastructure and existing networks can not afford this increase in population.
5. Technical losses in the network.
6. Mismanagement of existing networks due to lack of remote management of consumption, pressures and losses in the network.
7. Illegal connections or flat billing artificially increases water losses.
8. Some of the above factors lead to microbiological contamination of water making it unusabl.

For the realization of the project are used all the data of the project of the delivery line from the sources of Fushe Miloti, realized by the contractor of the World Bank. The project of the delivery line was realized in the field from the pumping stations in Fushe-Milot to the Former Chemical Warehouse, Warehouse 2, 2/1 and Warehouse 1. In warehouse 2 a small part of the outlet for the **GRP DN500mm** distribution network was implemented.

As supply points for the distribution network will be new warehouses which will be built on top of the existing ones due to lack of free land in the highest points of the city.

Importance of the project.

The purpose of this technical work is the design of the water supply distribution network of the city of Durres and the area of Keneta. The intervention in this area is done for:

1. Water supply area.
2. Improved water supply schedule in 24 hours,
3. Improving the amount of water per capita,
4. Improving water quality,
5. Quality and ease of operation and maintenance

The designer has taken into account the existing situation, new projects that have been implemented in recent years by the company, such as the delivery line from Fushe-Miloti and the lines in the distribution network that serve the new project. The designer has carried out the necessary topographic measurements, has carried out the geological study of the bases of the depots and the lines where the pipeline passes.

All buildings have been identified, their typology, number of floors and number of customers in the building.

In continuation of the work, all the distribution network lines were laid according to the need for water based on the experience of the design team and hydraulic calculations were performed for the whole scheme. The distribution circuit diagram is annular (closed) to maintain constant and partially open pressures on the periphery of the network. Areas with closed schemes are the city the lower part by the sea and Keneta the former area of land parcels. Areas with open schemes are hilly areas of the city, Keneta and Arapaj

Areas that are at a high quota above the quota of existing warehouses were treated as separate areas for which a new warehouse will be built above the 2/1 warehouse in the military area where the antennas of mobile companies are. Preliminary hydraulic calculations revealed problem areas that are not supplied with water, do not have the right pressure or have large hydraulic losses. Then all the dimensions of the pipelines were changed and the hydraulic scheme was recalculated several times until all the technical parameters necessary for a water supply distribution network were adjusted.

After the dimensioning of the network for which the technical parameters of the existing warehouses were set in advance, the calculations of different 24-hour, 7-day and 12-month scenarios were performed, for which the data were obtained that the capacity of the existing warehouses does not meet the needs of customers. . From the

hydraulic recalculation and the determination of the volume of reserve water according to the technical condition, the necessary volumes of the depots for the normal operation of the network were determined.

Sources of Water Supply

For the realization of the project are used all the data of the project of the delivery line from the sources of Fushe Miloti, realized by the contractor of the World Bank. The project of the delivery line was realized in the field from the pumping stations in Fushe-Milot to the Former Chemical Warehouse, Warehouse 2, 2/1 and Warehouse 1. In warehouse 2 a small part of the outlet for the GRP DN500mm distribution network was implemented.

As supply points for the distribution network will be new warehouses which will be built on top of the existing ones due to lack of free land in the highest points of the city. All existing warehouses are surrounded by private apartments and multi-storey buildings where it is not possible to expand the trail of new warehouses. The new reservoirs are Reservoir 1 from 3600m³ to 8000m³, Reservoir 2 from 1500m³ to 2000m³, Reservoir 2/1 from 6000m³ to 8000m³ and former chemical depot from 2000m³ to 2000 and above depot 2/1 on the hill to the antennas is planned to be built a warehouse 2000m³ which will supply water to all customers who are in quota above the quota of warehouses 1, 2 and 2/1.

In the areas where it is connected to the distribution pipe GRP DN500mm, a new connection well with maximum dimensions (7.6 x 3.1) m will be built, which will be equipped with butterfly-type valv with accumulator for remote control, water purification filter, pressure reducer, meter inductive water and by pass in case of equipment replacement see figure.

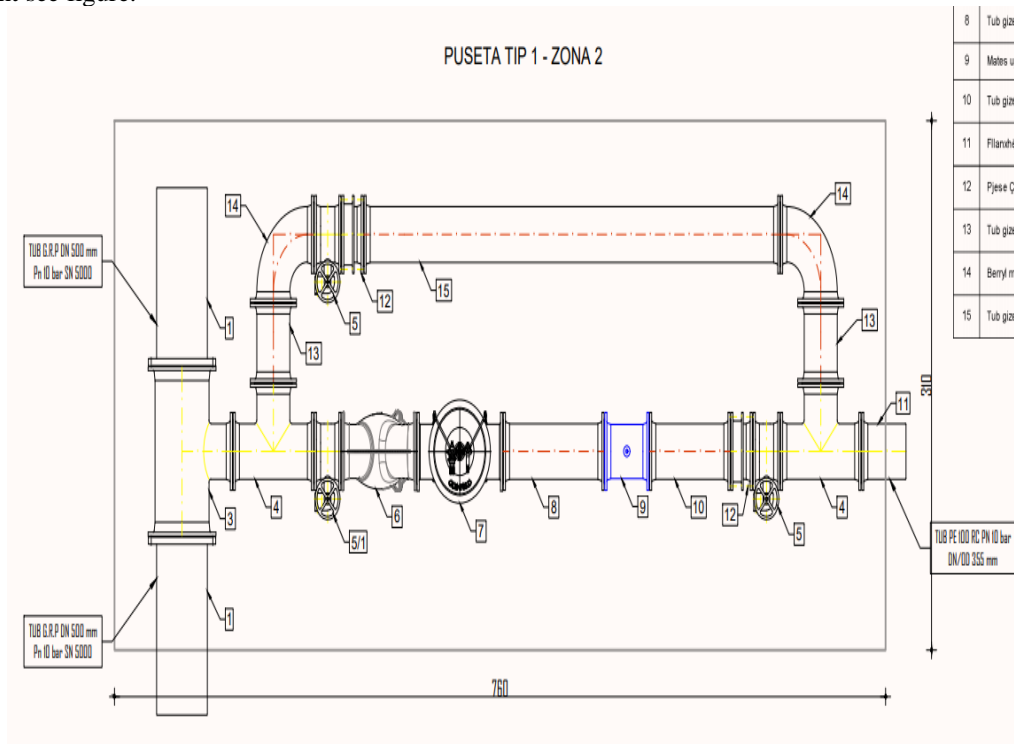


Figure 3:- The main node- supply for the first area.

Base Demand Assumption:

In Demand Management Report the daily demand of a customer (residential) has been estimated around 230 l/capita/day. Assuming that a residential unit is made up of 3.3 members, the derived customer load is around 760l/customer/day. If this load is distributed uniformly along the day, the flow it will be $760 \text{ l} / 24 \text{ h} / 3600 \text{ s} = 0.01 \text{ l/s}$. In WaterGEMS this is set as base demand or demand unit. The total daily demand is not uniformly distributed: it depends on some factors, mainly from customer water use habits. There is a large number of studies and scientific researchers all over the world dealing with factors influencing water demand. Among all, the Consultant based his assumptions on studies implemented in his country of origin, which is very close to Albania, not only geographically, but also regarding other factors, as it will be better explained in the next paragraph.

Peak Factors:

Assumption The scope of this paragraph is to assess a pattern for water consumption at “users’ level,” to be used for future optimized scenarios in Durres water network. This pattern has to be representative of the net flow coming out from the user-taps, therefore does not have to include the effect of water losses in tanks and distribution network as it happens, for example, considering the total outflow measured downstream tanks or, generally, in upstream pipes feeding the whole distribution network. Figure 4: Average Pattern in Durres area (table)

Time	0:00	0:42	1:31	2:25	3:30	4:17	4:55	5:28	6:07	6:47	8:02	9:03	9:38	10:30	11:15
Koeff.	0.38	0.3	0.24	0.22	0.26	0.39	0.57	0.85	1.21	1.53	1.72	1.69	1.55	1.42	1.35
Time	12:34	13:23	14:17	15:25	16:26	17:39	18:23	19:01	19:45	20:30	21:12	22:01	22:46	0:00	
Koeff.	1.32	1.33	1.27	1.21	1.14	1.13	1.21	1.29	1.31	1.18	1.02	0.83	0.66	0.38	

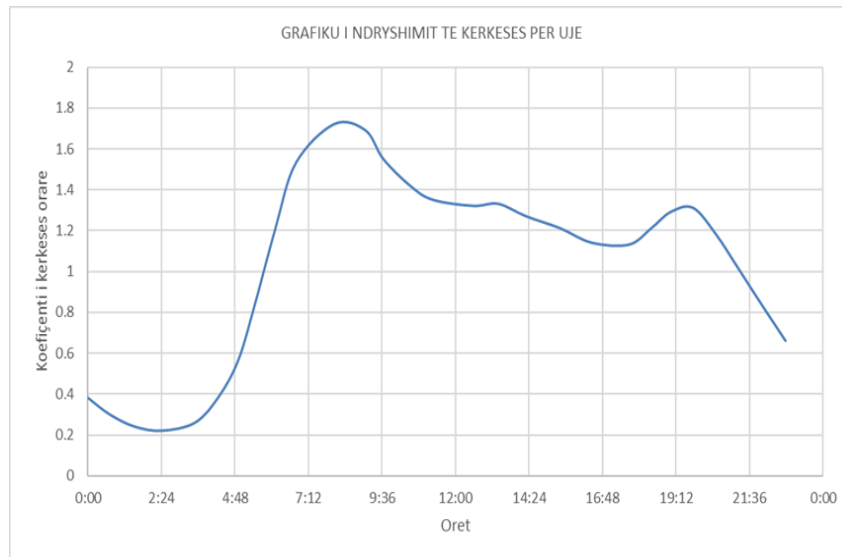


Figure 5:- Average Pattern in Durres area (graph).

Hydraulic calculations of the network

The hydraulic calculations of the delivery line are made with antennas of the formula Darcy - Weisbach which has the following form:

$$Q = S \sqrt{8 \cdot g \frac{R \cdot i}{f}}$$

Q - The flow that passes through the pipe

S - Cross section of the pipe

g - Acceleration of free fall

R - Hydraulic pipe of the pipeline

i - Hydraulic slope

f - The coefficient of hydraulic losses found with the formula:

$$\frac{1}{f} = -2 \cdot \log \left(\frac{k}{12 \cdot R} + \frac{2.51}{R_s \sqrt{f}} \right)$$

Re - Reynolds number

e - The coefficient of rigidity for plastic pipes is $k = 0.0015$ m.

Through successive approximations we find the value of f for our pipeline for the given flow

Network calculations are performed using the WaterCAD program

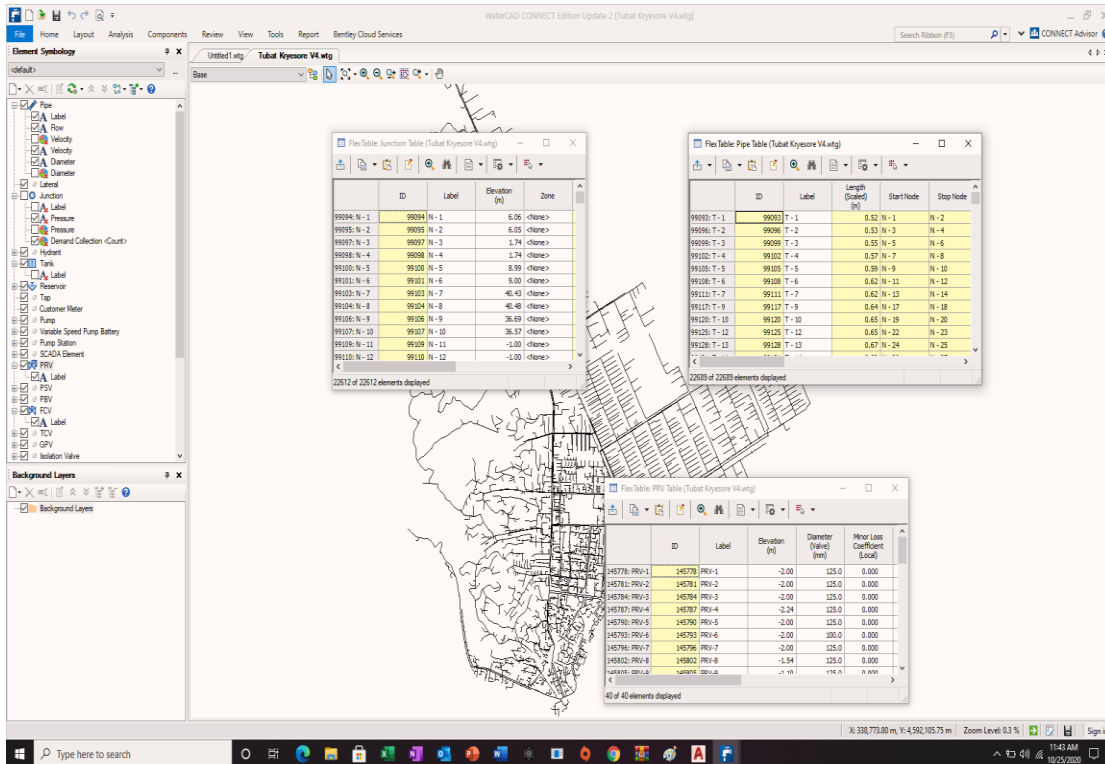


Fig.6:- Hydraulic modeling with water cad.



Fig.7:- Water distribution network.



Fig.8:- Six water supply areas.

Table 2:- DMAs Main features.

DMA No	Customer No	Supply Tank	Supply Source
SZ No 1	3000	Arapaj Tank	Xh.Zotaj
SZ No 2	12673	Arapaj Tank No 2	XH.Zotaj/New Source
SZ No 3	5100	Sh, Vlash NewTank	New Source
SZNo 4	10400	Tank No 1	XH.Zotaj/New Source
SZ No 5	18100	Tank No 2	XH.Zotaj/New Source
SZ No 6	2600	P.Romano Tank	New Source

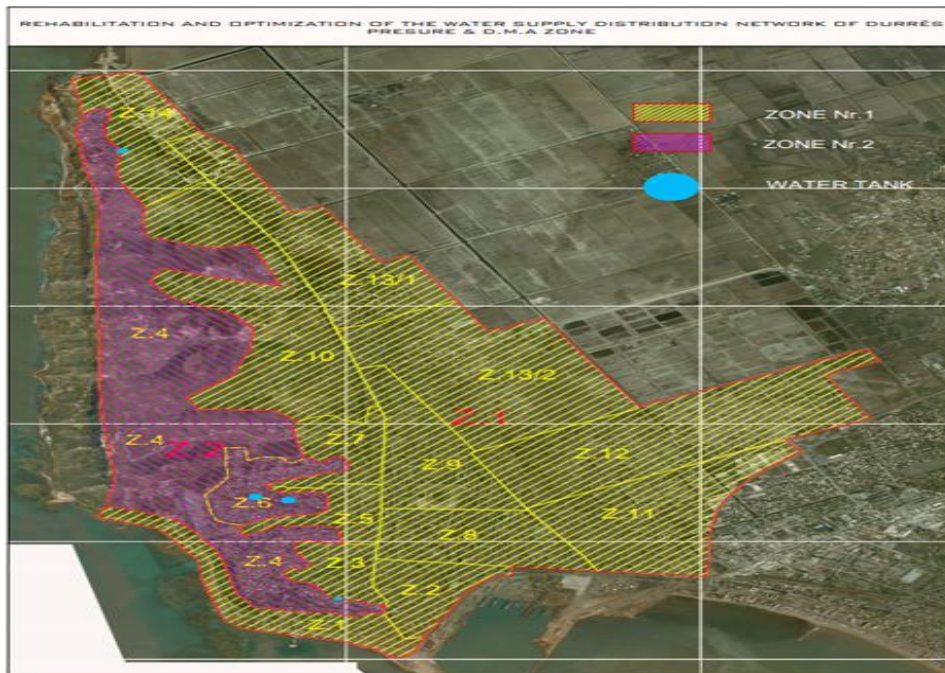


Fig.4:- Pressure zones and DMA's area.

The driving principle to SZ set-up is the elimination of direct supply and zoning the network to make possible supplying all areas through its tanks. The benefits of applying such principle are the following:

1. Directing water from the main transmission entirely into the storage tanks will help the Operator (DWU) to understand and monitor the transmission main even without a proper electronic monitoring system. The tank operators are experienced on standard reading procedures of flows and tank levels on an hourly basis.
2. Distributing water from gravity to the storage tanks will help and improve pressure management, by avoiding the pressure fluctuations to service connections and water hammer issues. Practically, in this case, all existing infrastructure will work under similar pressure conditions as it works now. Therefore, the losses will be increased only due to continuous supply, not because of pressure increase.
3. Supplying each zone through its storage tank would also contribute to understand the zonal demand distribution and allow DWU to take appropriate conservation and distribution measures in the future.

Conclusions:-

Remodeling and rehabilitation of the water supply network for the city of Durrës in the near future will finally solve the water supply 24/7 days. The advantage will be the operation of a much better quality after the operation of water distribution, monitoring of flow and pressure will be done in real time as a result of the new modeling of the distribution network and storage tanks. The network will work at optimal pressures and the cracks in the pipes will be much less.

Referneces:-

1. UKD- sh.a Water Supply and Sewerage Durrës /
2. Report on WDS rehabilitation/Optimization program/Lotti igengeria April 2018.
3. INVICTUS-company for hydraulic design and modeling
4. Albanian Regulatory Authority of the Water Supply and Waste Water Disposal and Treatment Sector.