Design Of Water Transmission Line, Flood Protection Works, and Water Supply Network for Al Laith City

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Introduction

hydraulic design of water transportation systems to ensure compliance with pressure and velocity. The project also extends to flood prevention and hydrologic design, including catchment analysis, flood risk assessments, and efficient water transport techniques. This strategy guarantees efficient flood control and water distribution, providing a robust and sustainable water resource system to serve the city's expanding population hydraulic design of water transportation systems to ensure compliance with pressure and velocity. The project also extends to flood prevention and hydrologic design, including catchment analysis, flood risk assessments, and efficient water transport techniques. This strategy guarantees efficient flood control and water distribution, providing a robust and sustainable water management system to serve the city's expanding population.

Objectives

- Conducting a hydrological and flood protection study including studying the basins that attack the city and calculating their values analyzing the two culverts and also designing two ditches to ensure and design the Irish crossing
- Design of transmission line, gravity system, and using two turbines to supply the cities adjacent to the line with energy and to obtain financial returns.
- Conducting a water hammer study for several cases, and implementing several types of protection for the line.
- Designing a water supply network and studying several fire cases and implementing solutions to ensure the reliability and efficiency of the network

Al-laith City

- The city of Al-Laith is in the Makkah region of Saudi Arabia. It is about 200 kilometers south of Mecca. It overlooks the western coast of the country and overlooks the Red Sea.
- The area: the area of the city of al-laith is about 15,000 square kilometers.
- Population: the population of the city of Al-Laith is estimated to be about 73,753. The population has cultural diversity, as it includes Arabs and Bedouins. Many of them work in the fields of agriculture, fishing, and trade.
- Climate: the climate is typing b (arid) by using Kappen – Geiger classification climate zones (by FAO).

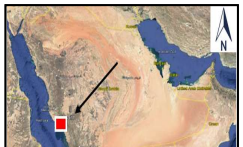

Figure 1 Showing the location of Al-Laith city in Saudi Arabia.

Figure 1.1 Al-Laith city location.

Transmission Lines

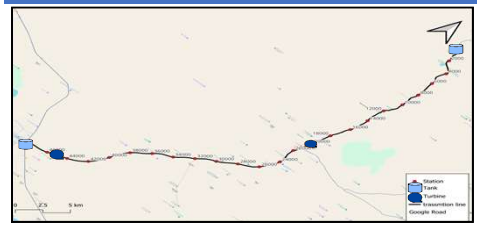

Figure 2 Plan for transmission line.

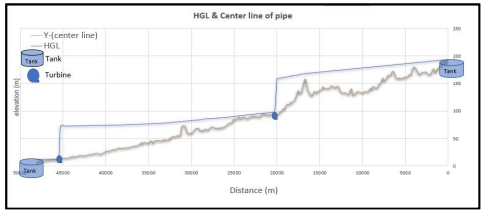

Figure 3 Profile for transmission line.

Water Hammer Analysis

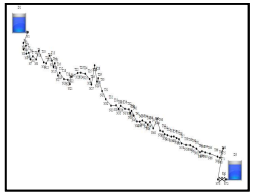

Figure.4 longitudinal profile of the transmission line from tank D_1 to tank D_2.

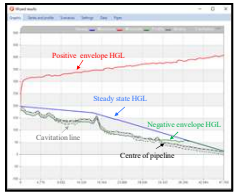

Figure.5 HGL without protection unsteady state results.

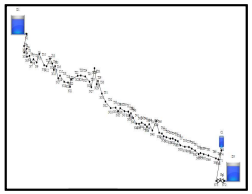

Figure.6 System with six air vessels next to each other and control valve at the end.

Figure.7 HGL with protection.

The impact of a water hammer on a gravity-based system with a control valve at the end, as shown in Figure 4, was studied. The highest pressure value in the steady state is approximately 180 meters, and when the valve is closed rapidly unsteady state condition, the maximum pressure reaches about 400 meters as indicated by the red line, The lowest pressure reached the cavitation limit -10 meters as indicated by the green line, as shown in figure 5. Therefore, two solutions have been found for this problem. The first solution is to use a pressure relief valve and three air vessels. The second solution is to use only six air vessels, as shown in Figure 6. When this solution is applied, the maximum pressure value reaches only 120 meters, and there is no negative pressure, which is considered safe for the line during a water hammer event, as shown in figure 7.

Water Supply Network

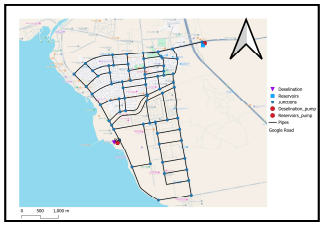

Figure.8 Layout of a water supply network.

Design water supply networks using QGIS, EPANET via QGIS plugins, and FIRE FLOW software. Flow: 914.51 l/s The total length of the network is 41.28 km, the velocities between (0.30–1.92 m/s), the diameters (100-750 mm), and the pressure (20.1- 35.1 m) Several case studies were conducted on the network including Maximum hourly, Max Daily and FIRE FLOW, and the last case was Max Daily and Two Fire Events. The selected case to be applied on the network was Maximum hourly to achieve and ensure the application of the fingerprint of the residents of Al-Laith city on the network.

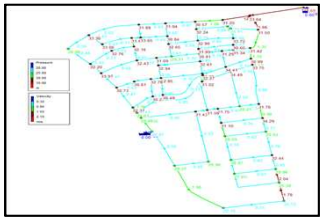

Figure.9 Layout of case Max Daily and Two Fire Events.

In this case, we studied what if Max Daily and Two Fire Events happened and chose the case with the worst impact on the network In applying this case, we had to change the pipe sizes due to the increased amount of flow coming out of the water tanks to ensure the application of this case.

Flow: 684.23 l/s

The Range of pressure is:

- 16-33 m

The Range of velocity is:

- 0.3-2.04 m/s

Flood Protection

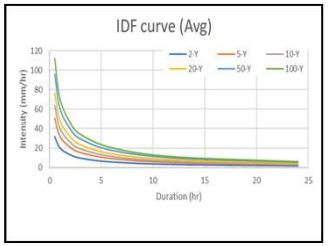

Figure.10 Average Intensity Duration Frequency (IDF) Curves.

The average intensity duration frequency for the catchment basin and the retorn period (RP 50).

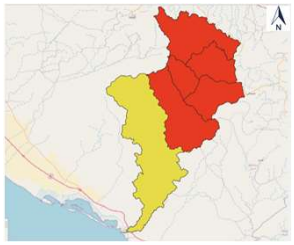

Figure.11 Delineation of Upstream Dam Catchment (shown in red), and Downstream (shown in yellow).

The dam took a large amount of 4980 m^3/s out of 7056 m^3/s from the total catchment basin. The values used with Area Reduction Factor (ARF). (For more details, refer to the project file).

Figure 12 Plan View for two channels and two culverts.

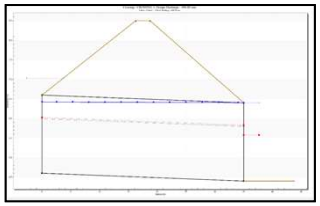

Figure 13 Cross-section for the first culvert.

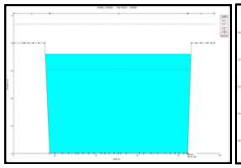

Figure.14 Proposed Cross-section for the first channel from HEC-RAS.

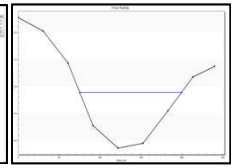

Figure.15 Cross-section for Irish Crossing from the Hydraulic Toolbox.

Conclusion

1. Transmission line: The total length of the water transport line is 48 km, the suction is 193 m, and the delivery is 15 m. After drawing the HGL we found that the maximum pressure head was 126 and To solve the problem, we placed two turbines in the middle of the line next to a city, and we placed the second turbine at the end of the line next to another city to reduce the pressure, and the maximum pressure head reached 66 m. The cost of 1 turbine is 338,082.56 SR, The total price for 2 turbines is 676,165.12 SR. There will be returns approximately after 4 months, and the annual return will be 1,077,199.87 SR. This will provide continuous financial returns and will provide electricity to the two cities in which we placed the turbine, it will serve the number of homes estimated at 1,000.
2. One of the two solutions is selected, Six air vessels with these dimensions: 7.3 m length, 2.92 m diameter and the volume 48.81 m^3 were used to solve the problem of water hammer in the water transmission line because it gave better results and required less costs.
3. Network :In the network summary, the Saudi code requirements were met, the network was designed on Maximum hourly, and the impact of fires was studied by using the Fire Flow program and studying Max Daily And Two Fire Events.
4. The Peak flow rate of the catchment basin was divided into two parts due to the presence of the dam and its value about 4980 m^3/s while the downstream the value about 2133 m^3/s. The values used with Area Reduction Factor (ARF).
5. Flood Protection: Two culverts and two channels were analyzed to determine their maximum flow capacity, which was about 400 m3/s. Then, a channel design was made to protect against flooding. Also, an Irish Crossing was created to protect the city from the stream attacking it from the eastern side. The volume of the flow that passed was 51.5 m3/s.

Software Used

Excel, AutoCAD, HEC-HMS, QGIS, Toolbox, Google Earth Pro, EPANET, HY-8, HEC-SSP, ALLIEVI, Fire Flow, HEC-RAS

For more details

REPORT FILE

information about us!