INSTALLATION AND TESTING OF PIPING SYSTEM FOR PROVISION OF WATER TO THE MECHANICAL ENGINEERING LABORATORIES UMARU ALI SHINKAFI POLYTECHNIC SOKOTO

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ABSTRACT
Water is an essential commodity in human life. Every day, man uses Water in one way or another. Water is used daily for drinking, washing, bathing, flushing, and other domestic uses. This paper presents the installation and testing of a piping system to provide Water to the mechanical engineering laboratories for easy accessibility to the office staff. The processes involved in the pipes' installation started with identifying the problems facing the water supply in the various labs and then costing the items for the work, measuring the distance from the overhead tank to the various labs, and excavation of the soil to provide a trench for burying of the pipes. The pipes were laid and connected from the overhead tank to the various destinations. The system was tested for leakage and correct supply, and after that, the trench was filled with soil. The results showed that the various labs will always be supplied with Water as long as the tank is kept in Water, even though there is a recommendation for a bigger tank to last longer.

Keywords: Pipe, Pipeline, PVC, Trench, Water

INTRODUCTION

All over the blue planet, even in the most rained-upon nations, people are engaged in conflicts over Water. There are debates about who should own, manage, have access to it, profit from it, control it or regulate it. Nothing on earth, not even land, is more contested. Rising populations and intensifying agriculture are creating ever more significant water needs. In many areas, there needs to be more infrastructure, or simply insufficient Water, to keep up with this demand. Even in 'green and pleasant' lands as disparate as the U.K. and New Zealand, hot summers are leading to an increasing frequency of dry rivers, droughts, and the prospect of insufficient Water at the time of year when it is needed the most. In the next decade, more than half the cities in Europe will experience water shortages in the summer. Much of Africa needs more potable Water. Vast land areas in the Americas and Antipodes are becoming barren, saline deserts because farmers rely on them for irrigation. Moreover, hydro squabbles spew forth where there are enough humans and not enough Water (Veronica, 2020).

Piping systems are prevalent throughout our everyday world. Most of us think of piping systems as underground structures used to convey liquids of one sort or another. To the novice, the concept of underground pipeline installation sounds relatively straightforward: a) dig a trench, b) lay the pipe in the trench, and c) fill the trench back in (Maharashtra, 2012).

While this simplified perspective of pipeline construction may be appealing, it needs to begin to address the engineering concepts involved in the underground installation of a pipeline. This chapter is written to assist in developing a comprehensive understanding of the engineering principles utilized in the underground installation of P.E. pipe (Maharashtra, 2012).

In the following pages, the reader will be introduced to the concept of a pipe soil system and the importance that the soil and the design and preparation of the backfill materials play in the long-term performance of a buried pipe structure. Specific terminology and design concepts relating to the underground installation of P.E. pipe will be thoroughly discussed. This will include fundamental guidelines regarding trench design and the placement and subsequent backfill of the P.E. pipe (CES, 2019).

This is intended to assist the pipeline designer in the underground installation of P.E. piping materials; it is not intended as a substitute for a professional engineer's judgment. Instead, a comprehensive presentation of these design and installation principles may assist the engineer or designer in utilizing P.E. pipe in a range of applications that require that it be buried beneath the earth (CES, 2019; Maharashtra, 2012).

Problems Statement

The importance of water supply to ant buildings must be balanced because Water is utilized in the entirety of man's affairs. Most of our offices are provided with convenience resources, which are utilized well only when there is a water supply. In the offices in the mechanical engineering laboratory complex, Thermodynamics, Fluid Mechanics, Mechanics of Machines, Strength of Materials and Metrology laboratories, the water supply has stopped for a long time. Therefore, the project will make it possible for the dwellers of the named offices to find it easier to ease them conveniently.

Aim and Objectives

The research aims to install water supply pipes in the four mechanical engineering laboratory complex offices. This project can be achieved through the following:

- Identify the route of pipelines leading to the four offices from the overhead tank
- Excavate the ground from the overhead tank to the various offices
- Connect the PVC pipes from the overhead tank to the four offices
- Bury the pipes connected after testing for leakage.

The project is of vital importance to the dwellers of the four offices. They will no longer go out searching for Water for their toilet treatment after using the facility. Unlike before, they had to go out searching for Water to flush the toilet after using it.

LITERATURE REVIEW

Water and the Human Body

Water is used in every cell of your body. Water travels throughout your body, carrying nutrients, oxygen, and wastes to and from your cells and organs. Water keeps your body cool as part of your body's temperature-regulating system. Water cushions your joints and protects your tissues and organs from shock and damage. Water acts as a lubricant for your joints, mouth and digestive system in saliva, nose, throat, eyes, and stomach as part of mucus. Water aids in the digestion and absorption of food, as well as in removing wastes from your body. Water also helps you maintain a healthy weight (Maharashtra, 2012).

Water Distribution

For efficient distribution, it is required that Water reaches end use with the required flow rate and pressure in the piping system. Three main types of distribution systems can be adopted in villages/towns (Ramalingam et'al, 2002):

Gravity Fed Distribution

When the ground level of the water source/storage is sufficiently higher than the core village/town area, such a system can be utilized for distribution. The Water in the distribution pipeline flows due to gravity, and no pumping is required. Such a system is highly reliable and economical.

Pumping System

In such a system, Water is supplied by continuous pumping. Treated Water is directly pumped into the distribution main with constant pressure without intermediate storage. Supply can be affected during power failure and breakdown of pumps. Hence, diesel pumps are also in addition to electrical pumps as stand-by to be maintained. Such a system works only in conditions where there is a continuous power supply and a reliable water source and where an intermediate storage system cannot be installed.

Dual/Combination

In such a system, both gravity and pumping systems are used. Such systems are used where there are variations in topography in a town/village. Minimum Residual Pressure in a distribution system should be 7 m for single storied, 12 m for two-storied and 17 m for three-storied buildings.

Distribution Lines

The lines carrying Water from storage to its end use (stand post/ household tap, etc.) are called distribution lines. Distribution pipelines consist of a main pipeline connected from secondary storage, sub-main pipes connected from the main pipeline, and service/branch pipes connected from the sub-main for distribution to households. Generally, Mild Steel (M.S.), Galvanised Iron (G.I.), High-Density Polyethylene (HDPE)/ Poly Vinyl Chloride (PVC) pipes, and Ductile Iron

(DI) pipes with 15-200 mm diameter are used in distribution. These lines are generally underground (1-3 feet below ground). Valves are used to control the distribution.

Piped Distribution System

A pipe system can vary from simple to highly complicated. Most piped systems have the same essential components: pipes, valves, fire hydrants, service connections and reservoirs. Piped systems may also give pumping stations; the following describes the various components that can be found in a piped system apart from pumping (Sharma & Swamee, 2005).

Distribution System Layout

Much like a tree, water distribution mains may be laid out in grids, loops, or branches. Grid or loop systems provide greater flow for protection and reduce the number of dead-end lines. Branch layouts result in several dead-end lines that can lead to bacteriological, taste, and odor problems. In addition, they require more frequent flushing and, thus, wastewater (Sharma & Swamee, 2005).

Water Supply Mechanism

Pump House and Pumping Machinery

The pump is used to fetch Water from a source like a bore well, open sump or groundwater storage and supply it to pipelines or elevated storage. There are three main components: a) pump, b) electrical or oil engine, and c) panel board. A pump house is constructed for the security and safety of machinery (Rossman, 2000).

Rising Main: The delivery line carrying Water from the pump to the storage tank (elevated or ground) is called the rising main.

Type of Pipe Material for Water Distribution

Various types of pipes are used for water supply systems, including metallic and non-metallic ones. The most common types of pipes used for water supply systems are (Swamee, 2001):

a) Galvanized Iron Pipes – metal pipe
b) Mild Steel Pipes, metal pipe
c) Poly Vinyl Chloride pipes - non-metal pipe
d) High Density Poly Ethylene Pipes – non-metal pipe
e) Ductile Iron Pipes
f) Stainless steel

For water mains, mainly G.I. and M.S. pipes or even large HDPE pipes are used, while for branch/service pipes, galvanized iron and HDPE/PVC pipes are most commonly used. DI pipes are used for both purposes (Swamee, 2001).

Joining and Laying of M.S. Pipeline

All care should be taken to clean the pipe's inner surface before laying. Cut the pipes as per the required length, thread with a threading die and file for proper cleaning where needed. Clean the edges and surfaces with a clean cloth. Light sandpaper or emery can be used lightly for cleaning if needed (Salzman, 2006; Sharma & Swamee, 2005):

2.7 Filling Excavated Pit after Laying of Pipes and Testing of Piping System

All backfill material should be free from cinders, ashes, slag, rubbish, vegetable or organic matter, boulders etc. Sand used for backfill should be natural sand, fine or coarse. The gravel used for backfill should be natural gravel with no boulders more than 50 mm. Backfill can be done with excavated materials like clay, sand, gravel, etc. After laying the piping system, fill the trench up to 300 mm and compact it by tamping. Carry out leakage testing of the piping system after partial backfilling. The leakage can be detected in two ways (James, 2006 and Swamee, 2004):

Hydraulic Test with Pressure.

All the piping system laid should be tested for leakage. At the village/town level, a leakage test can be carried out every 500-1000 m for such tests, mainly for the mains. The pressure gauge should be fixed at the lowest end of the pipe. The Water should be filled in from the lowest point in the network to be tested, and air vents should be provided at higher points. During such filling of the line with Water, air should be released from air vent pipes, and care should be taken to close air vents only when complete air has been released from the pipeline and a smooth flow of Water starts. Calibrated tank can be installed for water supply and collection. For the leakage test, 1.5 times the working test pressure of the pipes selected is done. There are specific formulas for testing the leakage amount at the end of each test. It will vary depending on the pipe length, number of joints in the pipeline, and pipe diameter. Consult the site engineer for its details. Solvent joined pipes should be tested within 24 hours of fixing. Fill the remaining pit in a layer of 50mm with required compaction and watering (Sharma & Swamee, 2005).

Disinfection of Pipeline

The mains of the water supply line should be disinfected before it is used. Flush the pipe with Water with sufficient velocity to remove dirt and other foreign material. Later, disinfection with chlorine water can also be done. A 20 mg/liter chlorine concentration can be used to chlorinate mains. Chlorine water should remain in the main for 24 hours for proper disinfection. Hence, all the valves should be closed along the mains before the procedure. The chlorine water can then be disposed of, and the pipeline can be cleaned with fresh Water (Sharma & Swamee, 2005).

Water Quality and Testing

Water from ground or surface sources is only sometimes potable for drinking and needs water treatment before supply to the water supply system. Following are some of the quality issues that are usually seen in various types of water sources (Sharma & Swamee, 2005):

Table 1: Different Sources of Water and Their Quality Test Procedures

Water Source	Type of quality issues
Surface water	
Lakes and ponds	Development of algae on top, development of Micro organisms, high turbidity in bottom layers. May be affected by organic and chemical pollutants by disposal of wastewater.
River, irrigation canals	Organic debris, mineral salts May be affected by organic and chemical pollutants by disposal of wastewater.
Ground Water	
Well, tube wells, hand pump etc	Salinity, fluoride, alkalinity, hardness Chemical contaminations due to disposal of domestic waste/industrial chemical near by

Source: Sharma and Swamee, (2005)

Types of tests to be conducted

a) Physical tests include temperature, turbidity, color, taste, and odor.

b) Chemical tests include pH, alkalinity, acidity, hardness, calcium, magnesium, iron, manganese, copper, zinc, aluminum, sulfates, fluorides, chlorides, nitrates, total dissolved and suspended solids, tests for toxic chemicals (lead, mercury, etc.), and tests for radioactivity.

c) Bacteriological examination for bacteria like coliforms and E. Coli (Sharma & Swamee, 2006).

METHODOLOGY

Materials Selection and Specifications

The materials used for the project execution were mainly PVC pipes, Unions, and Elbows. The gum was also used to glue the pipes together using the union.

Engineering Drawing of the Layout

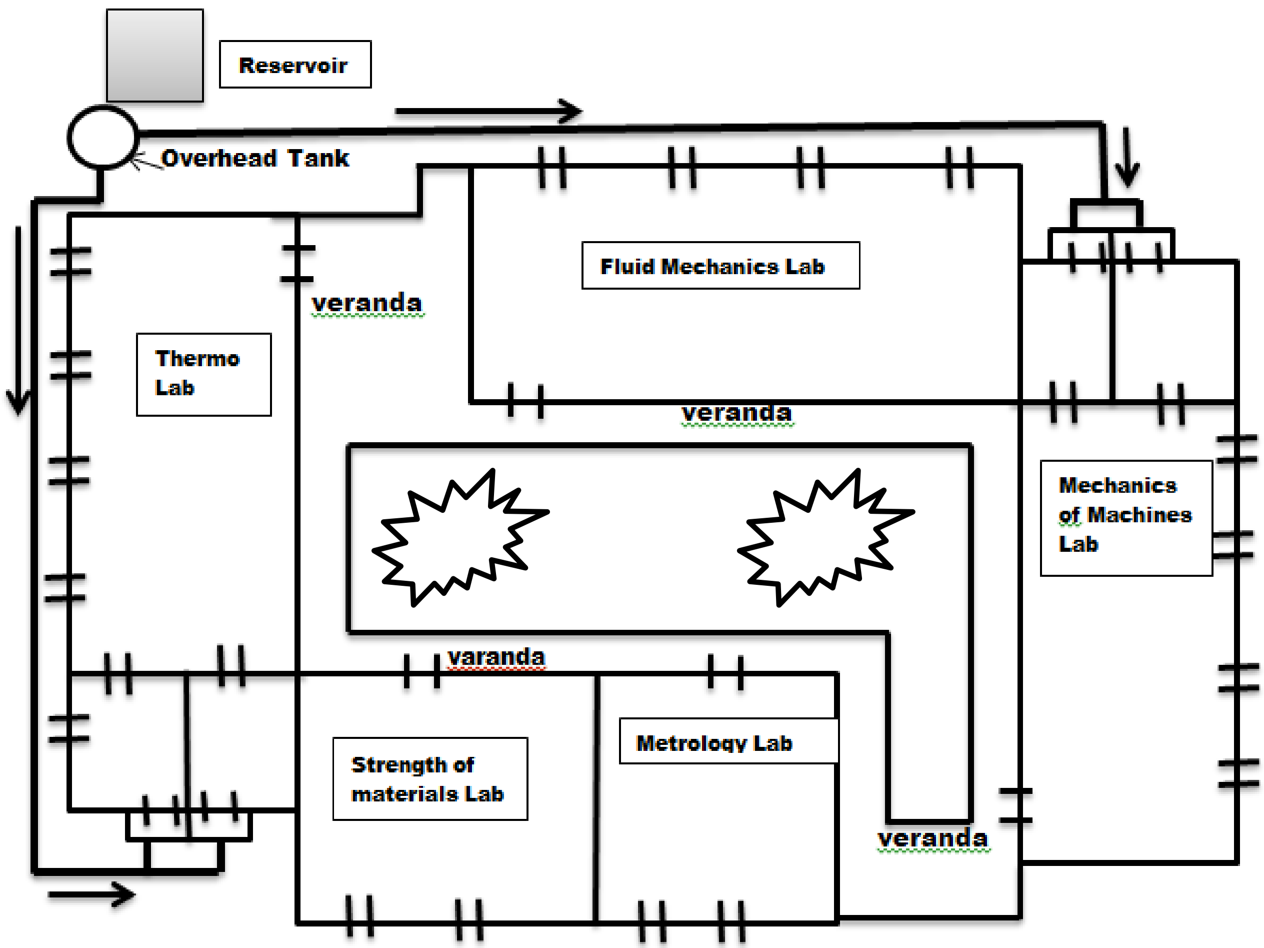

Figure 1: The Plan View of the Mechanical Engineering Laboratory Complex and Pipeline Layout. The Arrow shows the Direction of Water Flow from the Overhead Tank. Project Detail

After purchasing the plumbing fixtures, the project was executed by digging a trench from the overhead tank to the various offices via their toilets. After the trench was dug, the pipes were laid and connected using the gum from the overhead tank to the various end stations.

Testing, Results and Discussion

The testing process was conducted to ascertain the proper sealing of the piping connections before the trench was closed. The results show that Water flows into the various end stations, indicating the work was done correctly.

Plate 1: The Overhead Tank and the Reservoir that serve it Water

Plate2

Plate3

Plates (2) show pipelines at the back of Thermo Lab, and (3) show the Entry into the toilets of Thermo and Strength of Materials Laboratories.

Plate (4)

Plate (5)

Plates (4): Pipeline at the back of fluid mechanics and (5): the Entry into the Toilets of the Two Labs

CONCLUSION

The work was successfully executed and tested. The various offices in the complex had a well-distributed water supply. It will be concluded that the dwellers of those offices will no longer lack Water, and as a result, no one will go out to search for Water except if the overhead tank is empty.

RECOMMENDATION

The following recommendations are made based on the observations made on the project.

- More durable pipe materials order than PVC can be used
- The tank volume should be increased to make Water available for a more extended period
- The height of the tank can be increased to increase the pressure of the Water for effective distribution.

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