Istanbul Technical University

CEV 451E Water Supply & Environmental Sanitation
Homework Assignment 1:
Design of a Water Transmission Line

The duration for this homework is 3 Weeks!

1 Scope of the Work

In the scope of this assignment, you are asked to design a ≈ 3.3km long water transmission line that satisfies the design requirements. Your design will include not only the pipeline itself, but also all the necessary hardware, as well. You will work as teams and report the work done in a proper engineering format.

2 Data

A separate set of data is supplied to each team. A list of team members and data for each group can be found at http://web.itu.edu.tr/kircave/water_supply.htm. This set of data includes:

1. A topographic map showing a linear route that connects a source reservoir to a delivery point.
2. The plot of the longitudinal section (i.e. horizontal distance x vs. elevation z) along this route.
3. The tabulated data of the longitudinal section (i.e. x and z in two columns) along this route for 1m intervals.
4. The necessary population and unit consumption data to evaluate the design discharge (Q_{design}).

3 Design Criteria and Constrains

The design criteria and constrains for project implementation are given in Table 1.

The economic lifetime of the water transmission line is planned to be 50 years. Population estimation will be conducted assuming a saturation limit via the "declining growth method":

$$(L - P_{final}) = (L - P_{initial})e^{-k_d \Delta t}$$

For each team the initial population ($P_{initial}$), saturation limit (L) and declining growth coefficient (k_d) are given. The unit water consumption per capita will be taken as the maximum of daily fluctuations ($max\, q_{day}$), which is given as $150\, l/capita/day$.

4 Remarks on Design Strategy

With this assignment you will be conducting a typical design practice. The general design strategy for a water transmission line would be as such.

Table 1: Design criteria and constrains.

Parameter		Unit	Value	Remark
$\left(\frac{p}{\gamma}\right)_{max}$	Maximum allowable static pressure	m	45.0	will be checked under static conditions.
$\left(\frac{p}{\gamma}\right)_{min}$	Minimum allowable operational pressure	m	4.0	will be checked under maximum operational dischrage.
V_{max}	Maximum allowable flow velocity	m/s	2.0	will be checked under maximum operational dischrage.
Δz_{min}	Minimum allowable pipe burial depth	m	1.5	Minimum depth the pipe can be buried with respect to the ground level.
Δz_{max}	Maximum allowable pipe burial depth	m	4.0	Maximum depth the pipe can be buried with respect to the ground level.
$\Delta z_{desired}$	Desired pipe burial depth	m	$1.5 \sim 2.0$	Desired depth of pipe burial due to economic considerations.
$h_{reservoir}$	The water depth in the distribution reservoir	m	4.0	For the distribution reservoir at the delivery point: $h_{reservoir} = z_{reservoir} - z$
D	Commercially available pipe diameters	mm	$110, 120, ...$ $..., 690, 700$	Other pipe diameters cannot be used.
f	Darcy-Weisbach friction factor	—	≈ 0.015	Assumed to be constant.

Before starting the design, study the existing topography and implementation geometry of the transmission line.

Start with static conditions for structural safety of the system against high pressure.

Try to use the maximum possible hydraulic slope (J) in order to minimize the pipe diameter and define the hydraulic slope that the geometry dectates.

Add the necessary hardware for operational conditions (PDR, energy dissipation valves, air relief valves, drainage valves, pumping stations, etc.)

Try to use as less pumps as possible in order to minimize the implementation and operation costs.

You can use different pipe diameters for different sections.

You may slightly alter your route to get around topographical obstacles in order to save from excavation.

Keep your design as simple as possible, try to use round numbers and be exact. Omit too many changes in the design (pipe diameter, etc.) along the transmission line.

5 Remarks on Report Writing

Make sure that your report reflects the work you have conducted properly. It must be comprehensive but also brief. It should include the following sections: INTRODUCTION, AVAILABLE DATA AND DESIGN REQUIREMENTS, CALCULATIONS (step by step explanation of your design), DETAILED FINAL DESIGN and CONCLUSION AND REMARKS ON APPLICATION. The DETAILED FINAL DESIGN section should include a scaled longitudinal section of your final design where you pointed out the locations of all the necessary hardware with a proper legend. No handwriting is allowed. Both a hardcopy should be submitted and a softcopy (pdf,doc, etc.) should be e-mailed to the research assistant of your class (with a CC to the instructor) before 17:00 deadline.