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ANALYSIS OF WATER LOSS DUE TO SEEPAGE IN THE IRRIGATION CHANNEL OF BATU BULAN DAM SUMBAWA NTB

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ABSTRACT

This study aims to analyze water loss due to seepage in the irrigation canal of the Batu Bulan Dam in Sumbawa, NTB. Irrigation systems are vital for agriculture in Indonesia, but water loss from seepage significantly reduces water use efficiency. The Batu Bulan Dam plays a crucial role in supporting agriculture in the region, yet the poor physical condition of the canal, cracks, and high soil permeability cause substantial water seepage. This study uses Geo-Studio Seep/W 2018 software to model and analyze water seepage patterns in the canal. The results reveal that water loss due to seepage is significant, influenced by the canal's physical condition and surrounding soil properties. This loss negatively impacts agricultural productivity and the environment. Plants that do not receive adequate water suffer from drought stress, leading to reduced crop yields and lower product quality. Additionally, a decrease in groundwater levels can disrupt groundwater ecosystems. To improve irrigation efficiency, it is recommended to upgrade the canal to a permanent structure, conduct regular maintenance, and adopt advanced monitoring technologies. Dewatering and proper drainage management are also necessary to lower groundwater levels. Using protective layers and soil stabilization around the canal can reduce permeability. Furthermore, education and training for irrigation workers and farmers are essential for efficient water management. The findings from this study are expected to provide a foundation for developing effective solutions to reduce water loss from seepage, thereby supporting agricultural sustainability in Sumbawa, NTB.

Keywords: water loss, seepage, irrigation canals, irrigation efficiency, agricultural sustainability.

INTRODUCTION

Irrigation canals are the main infrastructure used to drain water to agricultural land. However, during the delivery process, some of the water can be lost due to seepage, especially if the channel is not in good condition or there are cracks in the channel walls. Water loss due to seepage in irrigation canals can be significant (Bautista et al., 2009). Water loss due to seepage can have a negative impact on agricultural productivity (Chahar, 2007a) (Chahar, 2007b). Crops that do not get enough water can experience drought stress, which in turn can reduce crop yields and the quality of agricultural products. In addition to having an impact on agricultural productivity, water loss due to seepage can also have a negative impact on the surrounding environment (Eshetu & Alamirew, 2018) (Bekele & Alamirew, 2021).

Excessive water loss can result in a decrease in groundwater levels and disrupt groundwater ecosystems. Water loss in the channel is not only caused by these factors, but also influenced by the condition of the soil such as the type of soil, the cross-sectional shape of the channel, the height of inundation in the channel which will affect the amount of seepage (Khan et al., 2015). Excessive water loss needs to be prevented by increasing channels to be permanent and controlling operations so that the available discharge can be used optimally to increase agricultural production and farmers' living standards. Relatively small water losses will improve the efficiency of irrigation networks (Marriage and Death, 2018), because irrigation efficiency itself is a benchmark for the success of agricultural operations in all irrigation networks (Kinzli et al., 2010) (Salmasi & Abraham, 2020).

In the general sense of Engineering, soil is a material consisting of solid mineral aggregates (granules) that are not cemented (chemically related) and from organic materials that have decayed (solid starch) accompanied by liquids and gases that fill the empty space between the solid particles (Das, 1995) (Sompie et al., 2018) (Nurmaidah & Suranto, 2022). Soil is used as a building material in a wide variety of civil engineering works. In addition, it also functions as a support for the foundation of the building. The size of soil particles is very diverse and varied. Based on the dominant particle size, soil can be classified as gravel, sand, silt or clay.

Table 1. Limitations on the Size of Land Groups

Group Name	Grain Size (mm)			
	Gravel	Pasir	Lanau	Lempung
Massactes Intitute of Technology (MIT)	>2	2 – 0,06	0,06 – 0,002	<0,002
U.S. Department of Agriculture (USDA)	>2	2 – 0,075	0,075 – 0,002	<0,002
Amrican Association of State Highway and Transportation Officials (AASHTO)	76,2 – 2	2 – 0,075	0,075 – 0,002	<0,002
Unified Soil Classification System (U.S. Army Corps of engineers, U.S. Borreau of Reclamation)	76,2 – 4,75	4,75 – 0,075	Fine (i.e. silt and clay) <0.0075.	

(Source: Das, 1995)

Seepage is a large amount of water or liquid that enters or exits a certain medium or soil mass. In 1856, Henry Darcy, a hydraulicist from France, conducted a study of the flow of water through a layer of soil. Since the velocity of water flow in the soil layer has a very small velocity, the flow is considered a laminer flow. Darcy found that the magnitude of the velocity at which the flow flows in or out of the soil layer is proportional to the hydraulic gradient. A group of power lines and equipotential bonding lines is called a power grid. The continuity equation in isotropic media presents two sets of diagrams that are perpendicular to each other, namely: power lines and equipotential bond lines. The line along which particles move from upstream to downstream through permeable soil material is also called the flow line.

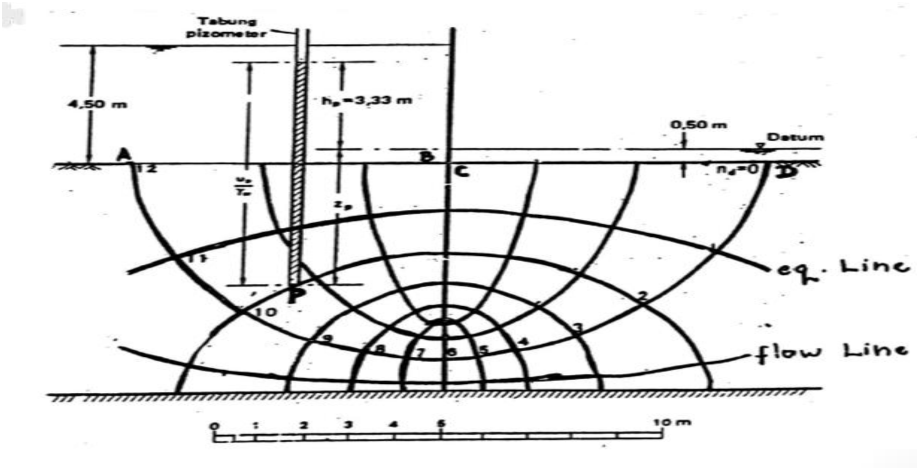


Figure 1. Current Network in Pavement Structure
(Source: Hardiyatmo, 2002)

1. Groundwater Flow

Permeability is a porous material property that allows the flow of seepage from a liquid in the form of water to flow through the pores. Soil is a permeable or porous material so that water can flow through the pores of the soil, so permeability is described as the property of the soil that drains water through the pores of the soil (Chairunnisa et al., 2021). In the soil, the flow properties may be laminar or turbulent. Resistance to flow depends on the type of soil, grain size, grain shape, mass density, and pore geometry. The total head (the total amount of pressure when water flows) is the elevation head (pressure due to water level) plus the pressure head (water pressure due to porous rocks) and added to the velocity head (pressure due to the speed of water flow). According to Bernoulli, the Total Head at a point can be expressed by the equation

h=z+P/Y_w +V^2/2g ……………….(5)

h : total head (m)
p/γw : pressure head (m)
p : water pressure (kN/m2),
γw : weight of water volume (kN/m3)
v : water velocity (m/sec),
with : elevation head (m).
g : Acceleration of gravity (m/s2)

2. Estimation of secretions

To estimate seepage losses in an optimization model programmed in Matlab with equations in each segment, the soil permeability coefficient is changed in a certain range based on pressure, elevation, and total energy level of flow in the soil (Fei et al., 2020) (Ahuchaogu I dkk).

$$Q_s = K_{yn}[(4\pi - \pi^2)^{1,3} + 2m^{1,3})^{\frac{0,77+0,462}{1,3+0,6}} + (\frac{b}{y_1})^{\frac{0,77+0,462}{1,3+0,6}}$$

……… (6)

Qs : Seepage flow rate (m3s−1)
Kyn : permeability coefficient (ms−1),

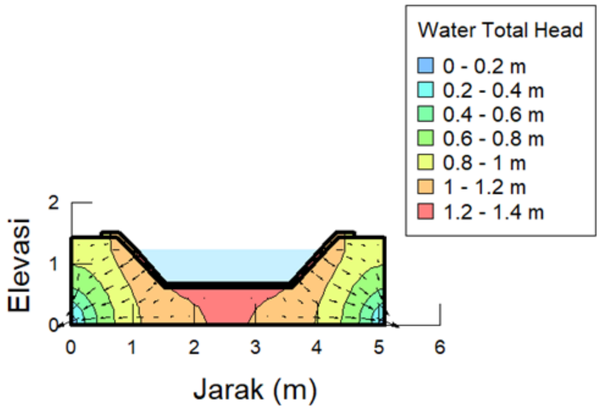
b : channel base width (m),
and : normal water depth in the channel (m).

METHOD

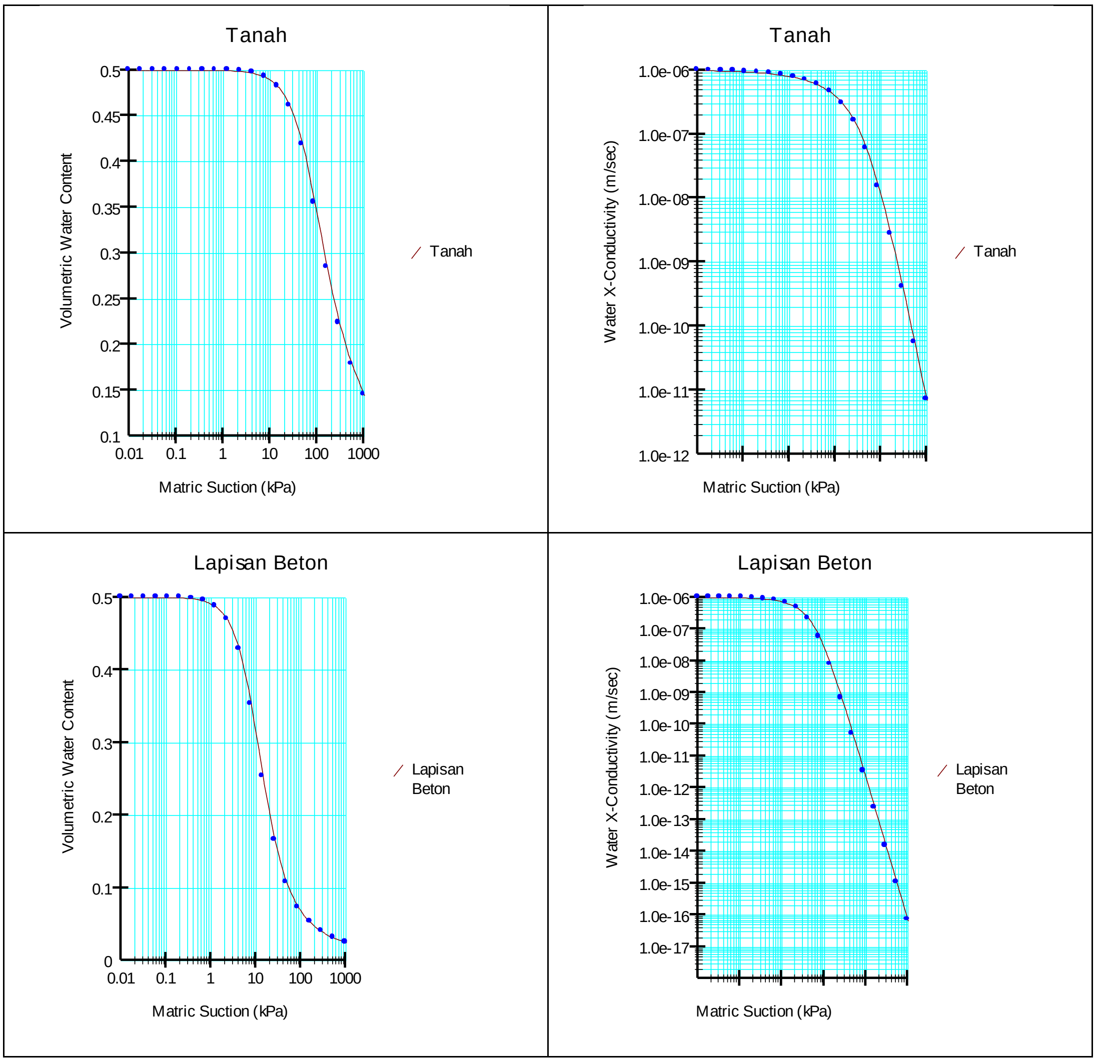
The research will be carried out in the irrigation network of the Batu Bulan Dam. This experiment was carried out in the irrigation network of the Batu Bulan Dam and created an irrigation network system to overcome seepage in the field (Azmeri et al., 2013). This research will develop research to calculate the water seepage rate, flow rate using excel analysis. The sample in this study uses 1 tool to be developed The research time is estimated to be 1 year by taking primary data and secondary data to develop a model of the rate of reduction of channel water seepage.

RESULTS AND DISCUSSION

The results of Discharge and Seepage Rate Analysis with the Geo-Studio Seep/w 2018 Program Area of Soil Media Model From the application of the Geo-studio Seep/w 2018 program can be presented in the figure below.



The results of soil media modeling with several types of groundwater level elevation using Geo-Studio Seep/W 2018 illustrate the fluctuations of groundwater level in the field. In the model results, it can be seen that there are equipotential lines and flow lines that represent the movement of water in the soil. Meanwhile, the color gradation in the model results shows potential differences that occur due to fluctuations in groundwater level. The rise and fall of groundwater level or fluctuations in groundwater level affect water potential. The red color in the model results shows the part with the greatest potential due to the influence of water fluctuations upstream, while the dark blue color indicates the land with the least potential.



From the figure above, it shows that the volume of water contan in the concrete layer and the soil layer is not the same in water absorption (Evcin et al., 2013) (Courageous, 2018). This means that in soil pairs, the greater the discharge of seepage through the soil medium at a certain time, the faster the liquid will flow through the soil medium. Conversely, in pairs of low secretion discharge, the velocity of fluid flow is also lower. In this study, the soil has a seepage rate proportional to the rise of groundwater level in the model carried out. This is likely because most soil samples are sandy. In addition, the value of hydraulic conductivity in the soil of the channel is also quite high, the value of hydraulic conductivity here greatly affects the ability of the soil to drain water.

CONCLUSION

Based on the results of the author's research using the Geostudio Seep/w 2018 program and with the state of soil characteristics in the irrigation canal of the Batu Bulan Dam, the fluctuation of the groundwater level will affect the seepage discharge that occurs where the higher the groundwater level will make the seepage discharge and the speed of water flow greater. The solution offered is to pay attention to the depth so as not to disturb the existing building to lower the groundwater level and the pumped water can be pumped to the nearest drainage system.

REFERENCES

Azmeri, A., Rizalihadi, M., & Yanita, I. (2013). Observasi Garis Freatis pada Model Bendungan Berdasarkan Kepadatan Tanah Melalui Model Fisik. *Jurnal Teknik Sipil ITB, 20*(1), 47–54.

Bautista, E., Clemmens, A. J., Strelkoff, T. S., & Schlegel, J. (2009). Modern analysis of surface irrigation systems with WinSRFR. *Agricultural Water Management*, *96*(7), 1146–1154.

Bekele, E., & Alamirew, T. (2021). *Water Delivery Performance and Dependability of Irrigation Interval in Tendaho Sugar Estate, Ethiopia*.

Bijani, M., & Hayati, D. (2018). *Farmers' Perceptions toward Agricultural Water Confl ict: The Case of Doroodzan Dam Irrigation Network, Iran*.

Chahar, B. R. (2007a). Analysis of seepage from polygon channels. *Journal of Hydraulic Engineering*, *133*(4), 451–460.

Chahar, B. R. (2007b). Optimal design of a special class of curvilinear bottomed channel section. *Journal of Hydraulic Engineering*, *133*(5), 571–576.

Chairunnisa, N., Arif, C., & Wibowo, A. (2021). Analisis analisis neraca air di Pulau Jawa-Bali sebagai upaya antisipasi krisis air. *Jurnal Teknik Sipil Dan Lingkungan*, *6*(2), 61–80.

Eshetu, B. D., & Alamirew, T. (2018). Estimation of seepage loss in irrigation canals of Tendaho sugar estate, Ethiopia. *Irrig. Drain. Syst. Eng*, *7*(3).

Evcin, Ö., Akkuzu, E., & Küçük, Ö. (2013). *ANADOLU AĞAÇ SİNCABININ (Sciurus anomalus (Güldenstaedt, 1785)) EKOLOJİSİ: KASTAMONU-ARAÇ MERKEZ ORMAN İŞLETME ŞEFLİĞİ ÖRNEĞİ*.

Fei, Y., Shu-Ping, T., Wen-Chao, X., Jin, G., & Yan-Long, Z. (2020). Extended state filtering with saturation-con-strainted observations and active disturbance rejection control of position and attitude for drag-free satellites. *Acta Automatica Sinica*, *46*(11), 2337–2349.

Khan, A., Khan, T. A., Sheraz, K., & Leghari, M. (2015). Relationship between seepage and discharge for Kabul River in district Nowshera. *Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences*, *31*(2), 249–259.

Kinzli, K.-D., Martinez, M., Oad, R., Prior, A., & Gensler, D. (2010). Using an ADCP to determine canal seepage loss in an irrigation district. *Agricultural Water Management*, *97*(6), 801–810.

Nurmaidah, N., & Suranto, S. (2022). Uji Pemadatan Standar Dan Uji Pemadatan Modified Terhadap Tanah Yang Dicampur Kapur. *Journal Of Civil Engineering Building And Transportation*, *6*(1), 50–60.

Salmasi, F., & Abraham, J. (2020). Predicting seepage from unlined earthen channels using the finite element method and multi variable nonlinear regression. *Agricultural Water Management*, *234*, 106148.

Sompie, G. M. E., Sompie, O. B. A., & Rondonuwu, S. (2018). Analisis stabilitas tanah dengan model material mohr coulomb dan soft soil. *Jurnal Sipil Statik*, *6*(10), 783–792.

Yürekli, H. (2018). *Ereğli İvriz Sağ Sahil Sulama Birliğinde Sulama Performansının Değerlendirilmesi*.