SEATUC 2023

February 23-24, 2023

PROCEEDINGS

of the 17th SOUTH EAST ASIAN TECHNICAL UNIVERSITY CONSORTIUM

"Toward Sustainable Innovation for Future Generations"

Suranaree University of Technology (SUT)

Organizer

Suranaree University of Technology (SUT), Thailand

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Table of Contents

Page

Message from Dean iv

Message from University Rector v

Conference committees vi

Editor's note ix

Presentation schedule x

The venue xii

Technical sessions xiii

Innovative sessions xvii

Article and abstract contents xxiv

Keynote speaker (KS)

Mechanical, Mechatronic and Robotics Engineering (01)

Electrical and Electronic Engineering (02)

Computer Engineering, Science, and ICT (03)

Energy and Environmental Engineering and Science (04)

Transportation and Vehicle Engineering (05)

Architecture, Planning, and Civil Engineering (06)

Materials Science and Engineering, Applied Chemistry (07)

Industrial and Manufacturing Engineering (08)

Bioscience, Bioengineering and Life Science (09)

Basic and Applied Mathematics and Science (10)

Geoinformation, Geoengineering, Geotechnology (11)

Business, Technology Management, Engineering Education (12)

Message from Dean

Associate Professor Dr.Pornsiri Jongkol
Dean
Institute of Engineering
Suranaree University of Technology

Dear distinguished guests and participants

It is a great honor and privilege for us to give a warm welcome to the invited speakers and all attendees of the 17th South East Asian Technical University Consortium (SEATUC) on February 23 and 24, 2023. At Suranaree University of Technology, a hybrid symposium called SEATUC 2023 will take place both online and in person. The technical and innovative session presentations, exhibitions, and workshops provide a great opportunity for all engineers, professionals, and graduate students at SEATUC member universities to share research achievements, knowledge, and experiences in order to promote sustainable development and improve the lives of all people.

As we have all seen, economic growth has occasionally resulted in negative social, environmental, and natural resource impacts. As a result, the conference's theme, "Toward Sustainable Innovation for Future Generations," offers the best chance for all students, engineers, scientists, and researchers to exchange ideas and strengthen collaboration in order to ensure that we all play a significant role in promoting environmental sustainability.

Despite the necessity of conducting the conference in a hybrid format because of the Covid-19 epidemic, I am confident that the organizing team which consists of Suranaree University of Technology, Shibaura Institute of Technology, and partner universities, will make every effort to ensure that the objectives of this conference are accomplished as effectively as possible. I truly believe that the gathering together of all participants in this symposium will benefit us in achieving long-term sustainable development, which will be beneficial to everyone and our entire world.

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Editor’s Note

Welcome to the Proceeding of the 17th South East Asian Technical University Consortium (SEATUC) in Nakhon Ratchasima, Thailand, which has the particular theme of "Toward Sustainable Innovation for Future Generations."

To ensure a conference of the best quality, papers will only be accepted after a rigorous review process. The conference this year had a considerable number of paper submissions. Each article was given between two and three program committee reviewers to evaluate it. The two-day conference features a variety of activities including keynote addresses, technical and innovative sessions, students’ posters, and workshops.

We want to acknowledge the authors gratefully for their technical contributions, which are included in these proceedings. We have been able to put these proceedings together because of their excellent contributions and dedication. The importance of the research presented at this conference signifies a movement in the maturity of sustainable development.

We would like to express our gratitude to all of our keynote speakers for making the extra effort to combine the contents with their varied and deep experiences to present notable lectures. We also want to express our appreciation to all of our presenters for their outstanding work in creating engaging presentations that meet the needs of participants at all skill levels. Last but not least, we wish the participants will appreciate the outstanding conference program we have prepared for the 17th South East Asian Technical University Consortium.

Editor

Movement of Saline Groundwater under Capillary Process in Dominant Sand Formation

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Abstract: Salt-affected soil is in the northeastern part of Thailand that covers almost 11.5 million rai. The 18% of the agricultural area resulting in a sharp decrease in soil productivity, vegetation cover, and biodiversity. Moreover, nearly 300,000 rai have led to be wasteland due to salt is the very high concentration in the soils. A capillary process is widely known as one of the processes inducing soil salinization. The capillary force in unsaturated soils results in an upward movement of saline groundwater to the soil surface. The salt concentration and salt crust gathered on the soil surface due to the evapotranspiration process. In this study, a 1-D physical model in the laboratory investigate the effect of soil properties on the upward movement of saline groundwater in the soils subjected to the capillary process. The samples of 3 types were sand soil, sandy loam soil, and silt loam soil. The soil samples had been compact into an acrylic tube of 15 cm in diameter. The saline groundwater table with the NaCl concentration of 2 g/L was kept constant at 57.5 cm from the soil surface. The results showed that soil structure highly affects the movement of saline groundwater in the soil subjected to the capillary process. The higher portion of fine particles with a small pore diameter in soil induces the higher position of the water content moved by the capillary force.

Keywords: *Capillary process, soil salinization, saline groundwater.*

1. Introduction

Salt-affected soil is in the northeastern part of Thailand that covers almost 11.5 million rai. The 18% of the agricultural area resulting in a sharp decrease in soil productivity, vegetation cover, and biodiversity. Moreover, nearly 300,000 rai have led to be wasteland due to salt is the very high concentration in the soils. The major source of saline soils in the Northeastern Thailand is the rock salts which are dissolved and accumulated in groundwater. During dry season, through capillary process, salinity from groundwater could move up and dispersed in the lowland where the groundwater table is very shallow [1]-[5]. In irrigated areas, during intervals in irrigation or during fallow periods when there is no downward flow of percolation water, water can move upward by capillary force. Furthermore, upward movement of groundwater by plant roots together with evaporation at the surface will facilitate salt accumulation in root zone or in the top soil layer [6]-[9].

Capillary rise of saline water is major source of saline soils. Fig. 1 presents capillary rise in capillary tube. The height of capillary rise (h_c) depends on the surface tension (T) and contact angle (α) which depends on diameter of the tube; the smaller diameter yields the greater α angle. Hence, the tube having smaller diameter will give the higher height of h_c.

$$h_c = \frac{2T_s \cos\alpha}{\rho_w g r} \tag{1}$$

when
r is radius of the capillary tube
T is water surface tension force
α is contact angle
h_c is height of capillary rise
g is gravitational constant
ρ_w is water density

Since upward movement of groundwater is driven by combination of evaporation and transpiration or Eva-transpiration processes, the water will be taken up by the roots or evaporate at the surface and salt will accumulate in the root zone or in the top layer. Regarding to Eq. 1, the radius of capillary tube inverse affects the height of capillary rise. The larger the radius of the tube results in the lower height of h_c. Though this relationship, this study adopts a large pore size material to form a layer called CB layer to block rising up of groundwater to the top soil layer.

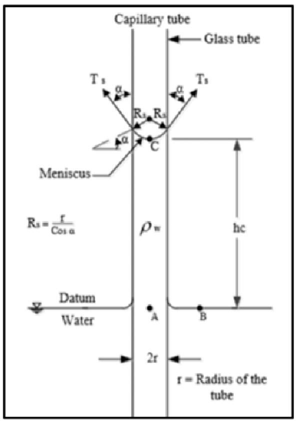

Fig. 1. Capillary tube and the relevant components relating to capillary rise.

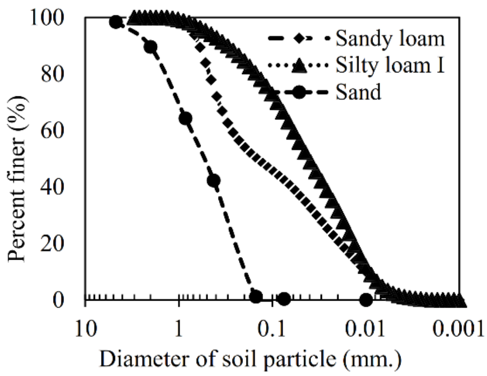

Fig. 2. Particle size distribution of the studied soil.

2. Experiment

2.1 Materials

The studied soils was mixture of sand and soil sampled from Ban Kok Phrom, NonThai Subdistrict, NonThai district, Nakhon Ratchasima province located in the North East part of Thailand, where the salt-affected soils have been found. This study used three mixtures of the mentioned soils; (1) sand of 98.5% and silt of 1.5%, (2) sand of 65.5% and silt of 36.5%, and (3) sand of 45.5% and silt of 54.5%. These soils are respectively classified as Sand, Sandy loam, and Silt loam based on United States Department of Agriculture (USDA). Particle size distribution of the studied soils are given in Fig. 2. The saline water was mixture of water and NaCl concentration of 2 g/L.

2.2 Experiment procedures

Fig. 3 presents setup of the experiments conducted in this study. For sake of comparable, the experiment was conducted with three soil columns, each column for each soil type. Each column was conducted as following procedures;

(1) The studied soil was compacted into the standpipe column to achieve a standard proctor density at air-dried moisture content, which was about 1.70 g/cm^3 for all studied soils. To control homogeneity of the compacted soil, the studied soil was compacted to 10 layers, each of equal height and amount of soil used in each layer.

(2) Saline water tank was connected to the bottom of the standpipe column as depicted in Fig. 3. This saline water was NaCl concentration of 2 g/L.

(3) To control the level of water table in the compacted soil column, the level of water in the saline tank was maintained at a specific depth. In this study, we maintained it at 57.5 cm below the surface of compacted soil.

(4) To reduce effects of light and heat that might impact the saline water properties and hence the experimental results, an opaque plate was then coated around the tested soil column as shown in Fig.3.

3. Results and Discussion

The experimental results in this study were presented by plotting the calibrated volumetric water content and Electrical Conductivity (EC) profiles to investigate movements of water content and salt content throughout the experiments, respectively.

Fig. 4, 5, and 6 present variation of water content profile in the Sand column, Sandy loam column, and Silt

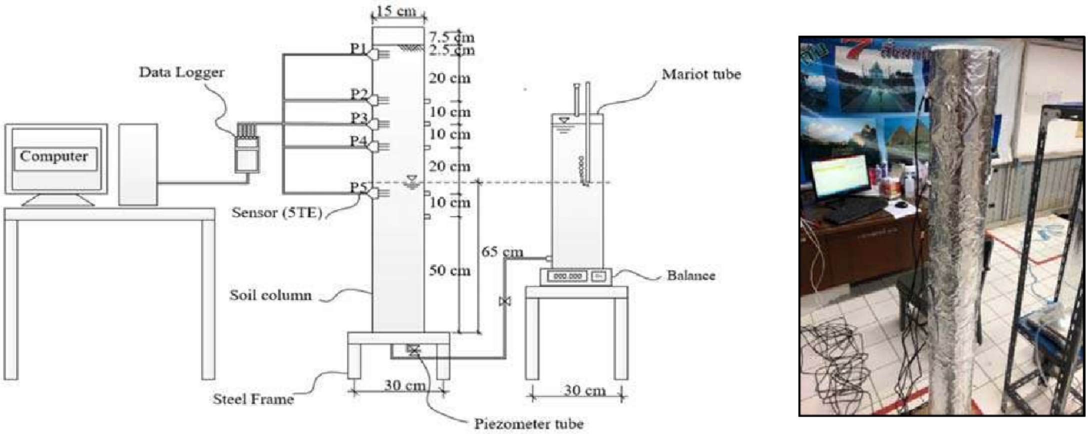

Fig. 3. Sketch and photograph of the physical model and soil column conducted in this study.

loam column, respectively. It is as expected that soil comprising more portion of small particle yields the higher capillary rise. The water content in the Silt loam column developed well from the bottom to the top of the column and reach the volumetric water content of 0.24at 240 hr. While the water content after 240 hr in Sand column was never change from the beginning.

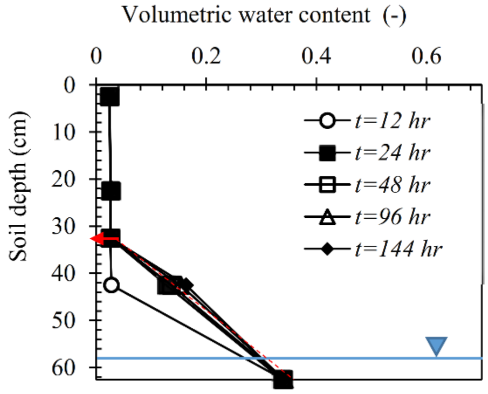

Fig. 4. Water content profile in the Sand column.

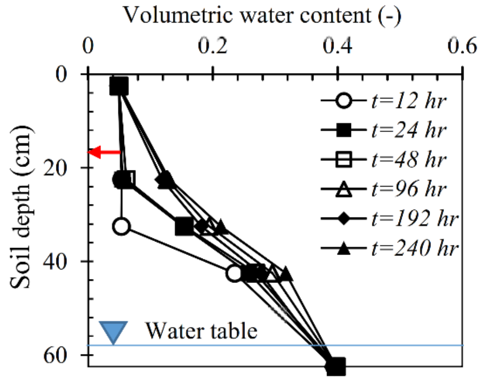

Fig. 5. Water content profile in the Sandy loam column.

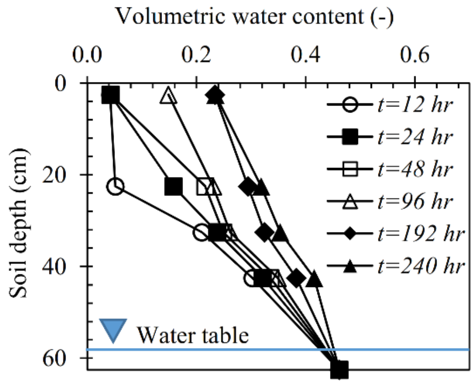

Fig. 6. Water content profile in the Silt loam column.

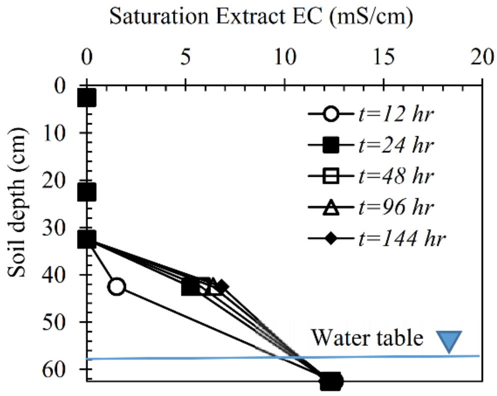

Fig. 7. EC profile of the Sand column.

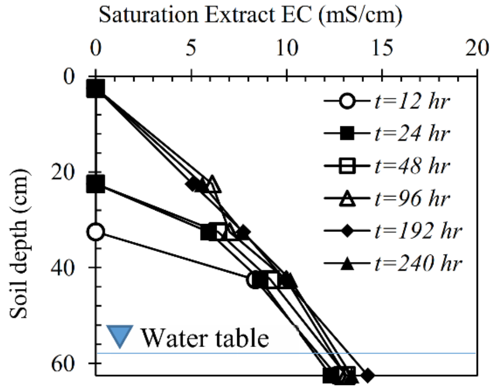

Fig. 8. EC profile of the Sandy loam column.

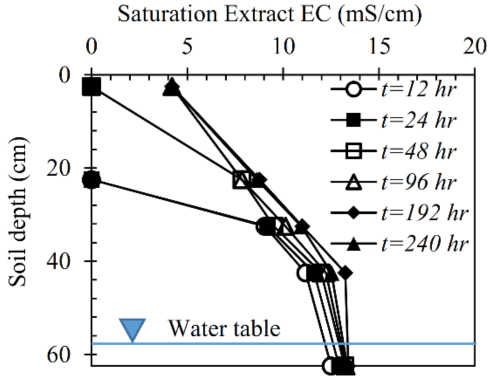

Fig. 9. EC profile of the Silt loam column.

Fig. 7, 8, and 9 present variation of EC profile in s in the Sand column, Sandy loam column, and Silt loam column, respectively. Similar to the development of water content, the magnitude of EC developed well from the bottom to the top of the column for the Silt loam column. While the EC in Sand column was near zero from the column surface to 30 cm depth.

4. Conclusions

This report study vertical movement of saline water under effect of capillary force. The study was conducted with physical model of 3 standpipe soil columns of different soil types; Sand, Sandy loam, and Silt loam. The results showed that soil structure highly affects the movement of saline groundwater in the soil subjected to the capillary process. The higher portion of fine particles with a small pore diameter in soil induces the higher position of the water content moved by the capillary force. The magnitude of EC indicating saline content in the soil. It is shown that the magnitude of EC is clearly related to the magnitude of water content. Hence, the soil with more portion of small particles yields the higher capillary rise, and hence saline content.

Acknowledgment

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