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COVER PHOTO (FRONT) SUNSET AT LOSARI BEACH, MAKASSAR (courtesy of A.Y. Baeda): LAKE OF HASANUDDIN UNIVERSITY, PURA ULUN AT BEDUGUL LAKE (BACK)

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Foreword

In many countries, its capital and major cities have been developed in low-lying area exposing to various stresses from nature and human treats. As a result, natural lowlands are turned into highly vulnerable area in safety, economic and environmental aspect. New record of the highest temperature and precipitation in many region of the world has challenged the knowledge and technology for protecting life, property, and ecological system in lowlands.

To achieve "Sustainability of Lowland to Climate Change and Natural Disaster", not only main themes as for previous ISLT like Geotechnical & Geo-environmental Engineering, Water & Environmental Engineering and City Planning and Management, but also new themes on Coastal Engineering and GIS Application for Lowland Management are concerned in the 8th International Symposium on Lowland Technology (ISLT2012).

In this year, the word "Lowlands" has brought together more than 100 researchers and engineers in related fields from 15 countries to share their great experience on coping with various problems in lowlands. Six outstanding speakers are invited to give one special lectures: Prof. D. T. Bergado (Miura Lecture); two invited lecture: Prof. D. A. Suriamihardja and Prof. W. Wangsadinata; and three keynote lectures: Prof. S. L. Shen, Prof. J. C. Chai and Dr. Olivier Hoes.

This symposium is organized by International Association of Lowland Technology (IALT) and Institute of Lowland and Marine Research (ILMR), Saga University with cooperation of Department of Civil Engineering, Hasanuddin University, Indonesia. I would like to extend my sincere appreciation to Prof. M. Madhav, the President of IALT, Prof. H. Araki the Chairman of the International Advisory Committee and Organizing Committee for their support.

I sincerely wish to express my gratitude to the International and Local organizing committee and all other staff of ILMR for their great contribution. Finally, I would like to thank all the authors for their participation. Without all of you, the symposium will never be successful.

Lawalenna Samang
Local Chairman of ISLT2012

President’s Address

Institute of Lowland Technology (ILT) founded in 1991 and renamed as Institute of Lowland and Marine Research has come a long way. Apart from undertaking research and education in the specific areas relevant to problems and issues of lowlands all over the world but especially in the Asian Region, a major activity has been the conduct of International Symposia on Lowland Technology fondly referred to as ISLT. These Symposia offer a great opportunity for researchers, academics, policy makers, etc., who all are interested in studying the various issues of planning, development and management of lowlands to meet once in two years to exchange ideas and developments and to share knowledge for the common benefit of all. The need for interactions is felt continually with natural disasters striking almost all countries of the region. The saddest has been the catastrophic earthquake off the coast of Japan last year. The vulnerability of coastal areas has been once again exposed with the disastrous ten to twelve meter high Tsunami. Similar events in the other regions especially in Indonesia remind us all the need for continued research and study of coastal lowlands.

Following the successful conduct of ISLTs in Saga, Bangkok and Busan, the 8th Symposium in the series is a wonderful opportunity to meet in the picturesque island of Bali thanks to the great efforts of Prof. Samang, Dr Triharianto, Mr Abdurrahman, etc. The five major themes of „Geotechnical/Geo-environmental Engineering‟, „Water & Environmental Engineering‟, „City – Urban Planning & Management‟, „Coastal Environmental Science & Engineering‟ and „GIS Application for Lowland Management‟ with twenty seven subthemes would cover all or most of the relevant topics of interest to everyone. Prof. Bergado, the eminent researcher and personality has been invited to present the third Miura lecture. With several keynote and invited lectures the event promises to offer the best occasion to interact and get intellectually stimulated.

ILT and ISLT have been successful because of the foresight of the founders, in particular, Prof. Norihiko Miura. They have been fostered and nurtured by eminent personalities such as Prof. Poorooshasb, Prof. Hayashi, and the members of the Councils all these years. I would like to place on record the help, support and cooperation received from the Executive President Prof. Araki, Secretary General Dr Azizul Moqsud, Prof. Bergado, the conference organizers for the success of the symposium.

Wishing the Symposium a be great event to be remembered and cherished and looking forward to meet you all,

Madhav Madhira

President, IALT

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The Editors would like to thank the following individuals for their assistance in refereeing submitted papers for ISLT 2012.

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ARTIFICIAL IMPERVIOUS/HARDPAN LAYER FOR REDUCING PADDY FIELD'S PERCOLATION RELATED TO WATER SAVING IRRIGATION

A. Sapei[1] dan M. Fauzan[2]

ABSTRACT: Irrigation efficiency can be improved at the time of delivery (conveyance), distribution and application. Water losses in the form of evaporation, leakage, seepage, percolation and water waste are reduced to a minimum. The purpose of this study is to examine the role of artificial impervious layer in reducing percolation of paddy field related to water saving irrigation and to improve efficiency. The impervious layer is made by compacting the soil below the plow layer by using soil stamper and baby roller. The impervious layer thickness is obtained about 12 cm and the maximum hardness were 9.41 – 13.28 kg/cm^2. The percolation obtained from 7.9 to 21.3 cm/day. Relatively smaller percolation obtained from plot which was compacted by using baby roller. But the obtained percolation is still too big for the paddy field which is only about 4 mm/day. This may be caused by the conditions of the plot that has very high percolation rate (508.8 cm/day).

Keywords: Paddy filed, percolation, artificial impervious layer, efficiency.

INTRODUCTION

An adequate water supply is important for plant growth. When rainfall is not sufficient, the plants must receive additional water from irrigation. Various methods can be used to supply irrigation water to the plants, namely surface irrigation, sub-surface irrigation, sprinkler irrigation and drip / trickler irrigation. Surface irrigation has low efficiency and drip/trickler irrigation have the highest efficiency.

More recently, non-agricultural water demand (domestic, industry, etc.) are increasing with the increase in population and living standards, especially when associated with the issue of global warming and climate change. Because of that, it is necessary for saving in the use of irrigation water.

Efficiency is influenced by a large loss of water, either evaporation, seepage, percolation, seepage, or lost due to mismanagement. This water loss occurs during delivery (conveyance), distribution and application in the plot. To improve efficiency, the loss of water should be reduced to as small as possible.

Percolation on new developed paddy fields are relatively large and required irrigation water as much as 3 to 5 times than normal (DPU, 1986) and the efficiency is relatively low. This field have no formation of impermeable layer below the topsoil (plow).

Koga (1991) stated that excessive percolation rate may also result in an increase in the cost of irrigation, soil leaching, cold water damage (in the cold) and landslide (in the sloping area).

The rate of optimal percolation are very different from place to place. In Japan, the rate of percolation of the recommended range between 15-25 mm / day in order to wash the toxic substance (Nakano, 1985). In the tropics, leaching toxic materials are not required, therefore percolation paddy field in the tropics can be very small (Ghildyal, 1978). For the paddy fields in Indonesia, Departement of Publik Work (1986) suggested percolation rate ranged between 3-5 mm / day.

According to Koga (1991), methods that have been developed to minimize percolation rates are as follows:
a) soil dressing, by putting a layer of clay beneath the coarse-textured topsoil.
b) a plastic layer, i.e by putting a plastic sheet under the topsoil.
c) artificial impervious layer, i.e by developing impervious layer below the topsoil. Impervious layer is made by means of compaction.

Yamazaki (1971) states that the impervious layer formed by compaction can reduce the rate of percolation paddy field in Japan in an area from 1000 mm / day to less than 20 mm / day. From small-scale research, impervious layer formed by compaction can reduce the percolation from 5.39 mm / day to 1.48 mm / day (Sapei, 2000).

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[2] Lecturer, Civil and Environmental Engineering Department, Bogor Agricultural University

AIMS

The purpose of this study is to examine the role of artificial impervious layer to reduce percolation of paddy field related to water-saving irrigation and high efficiency with medium-scale research.

METHODOLOGY

The study was conducted at the Cikarawang experimental field, Darmaga IPB Campus from March - November 2011.

The experimental paddy field is located on the slopes. Groundwater table is deep and the percolation is very high. Almost every year the field is planted with rice.

This research used several equipments: soil sampling equipment, soil compaction test equipment, permeability test equipment, compaction tools (soil stamper and baby roller), and percolation gauges.

Study was conducted in three stages, i.e:

1) Soil compaction test and permeability measurements

Testing was conducted by standard Proctor test (SNI No.. 1742-1989-F) in the laboratory, to obtain optimum water content and maximum density. Soils tested were taken from the depth of 20-40 cm.

Characteristics of soil used are presented in Table 1 below.

Table 1. Soil characteristics

Item	amount
Fraction:	
Sand (%)	9.83
Silt (%)	35.49
Clay (%)	54.68
Particle density (g/cm^3)	2.73
Bulk density (g/cm^3)	1.12
Permeability (cm/day)	3.9 x10^5
Liquid limit (%)	72.95
Plastic limit (%)	44.73
Plasticity index (%)	28.22

Permeability of compacted soil was measured by using a falling head permeameter.

2) Artificial impervious layer development

Impervious layer is formed by compacting the bottom soil layer (subsoil compaction), by removing the top soil layer (about 20 cm) in advance.

Treatments for Artificial impervious layer development:

- Compaction Tool: soil stamper or baby roller
- Compaction treatment: crushing and compaction, or compaction only
- Compaction energy: 80% of the standard energy (soil Stamper 3 x; baby roller 9 x); 100% of the standard energy (soil Stamper 4 x; baby roller 12 x); or 120% of the standard energy (soil stamper 5 x; baby roller 15 x)

The layout of the plots was as Figure 1.

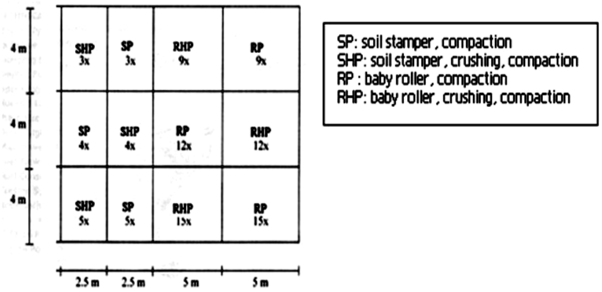

Fig. 1 The layout of the plots

Soil compaction in the field was as Figure 2 below.

(a) (b)

Fig. 2 Compaction using soil stamper (a) and baby roller (b)

3) Percolation measurement

The rate of percolation is determined by measuring the change in the depth of ponding water. Percolation rate calculation using the following equation:

$$P = \frac{h_1 - h_2}{t}$$

Where: P: percolation rate (cm / day), h_1: high initial water level (cm), h_2: water level after time t (cm) and t = time of measurement (days).

RESULTS AND DISCUSSION

Soil Compaction Characteristics

The relationship between the dry density and the water content obtained from laboratory compaction tests described by soil compaction curves (Figure 3). Figure 3 indicates that the optimum water content is 35% and a maximum dry density is 1.390 kg/m^3 (1.39 g/cm^3).

Permeability of compacted soil depends on soil density, and range from 7.9x10^{-2} cm/day to 6.10 cm/day. While the permeability of the original soil is 3.9x10^5 cm/day. Smallest permeability obtained from soil that compacted at 35% water content (optimum water content) as shown in Figure 4.

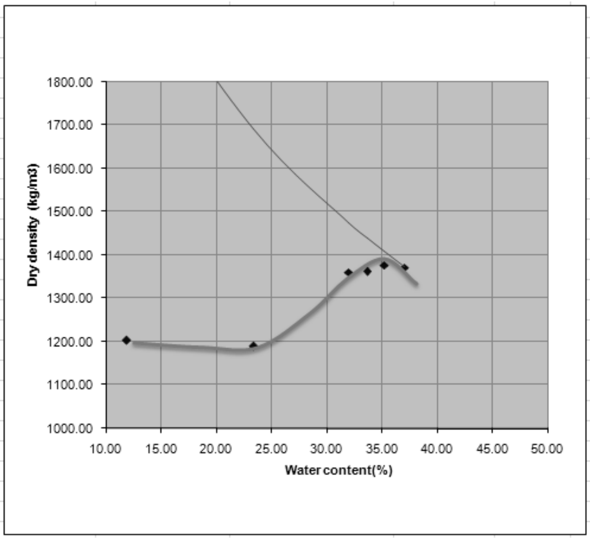

Fig. 3 Compaction curve (from laboratory tests)

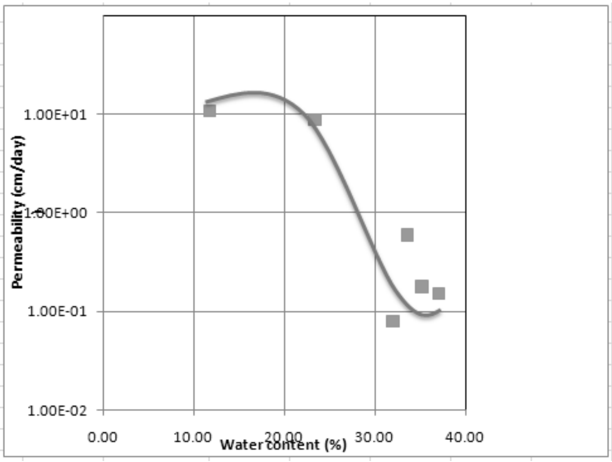

Fig. 4 Permeability of compacted soil (from laboratory tests)

Artificial Impervious Layer

The thickness and hardness of artificial impervious layer on the field were obtained by measuring soil penetration resistance (cone index) as shown in Figure 5. Figure 5 indicates that the thickness of impervious layer were about 12 cm and the maximum hardness were from 9.41 kg/cm^2 – 13.28 kg/cm^2.

Figure 6 also shows that soil compaction with crushing using soil stamper can reduce percolation larger than the soil compaction without crushing. However, when using a baby roller, compaction without crushing can reduce percolation greater. This finding is presumably due to differences in the process of compacting.

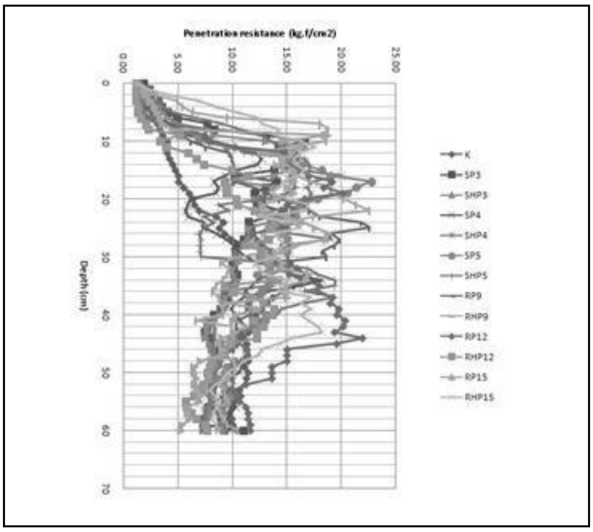

Fig. 5 Penetration resistance profiles

Percolation Rate

The percolation rates that measured by observing the decrease of ponding water is presented in Figure 6. Figure 6 shows that the percolation from paddy fields with artificial impervious layer were ranged from 8.8 cm/day to 21.3 cm/day. Percolation rate of paddy field without impervious layer was 508.8 cm/day. This study recognized that the artificial impervious layer reduce percolation of paddy field to become 0.02 time of initial percolation. But, according to Irrigation Planning Standards KP-01 (Departement of Publik Work, 1986), this percolation is still too high for a paddy field.

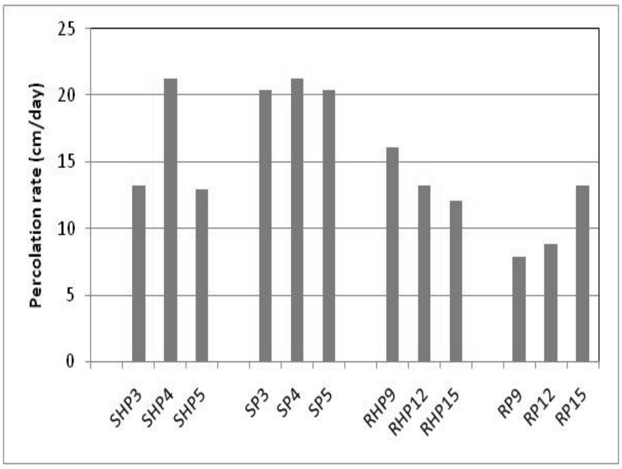

Fig. 6 Percolation rates

CONCLUSIONS

1. Impervious layer developed by compaction has a thickness of about 12 cm and hardness between 9.41 – 13.28 kg/cm^2.
2. Impervious layer reduce percolation rate of paddy field from 508.8 cm/day to become 7.9 - 21.3 cm/day.
3. The lowest percolation rate was obtained from crushing and compacting using baby roller.
4. Artificial impervious layer can be applied to reduce percolation paddy field.

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