EFFECT OF DENSITY SOIL TO WATER RECHARGE (INFILTRATION) IN URBAN OVERLAND FLOW

by Zakki Fuadi Emzain

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ABSTRACT : Soil has different conditions depend on its formation in the past and their treatment in the period of running time. The process of the hydrological cycle is also influenced by soil conditions, namely the rain fall on the surface of the ground. Land has undergone many changes due to the treatment needs of human activity. The process of soil influence on the hydrological characteristics is the presence of drainage and water infiltration into the soil that affect the water balance in the soil and on the surface of the earth. This study aims to determine the effect of soil density on water infiltration (infiltration) of several types of land in urban areas. In this case, the transactions are carried out research on some soil types with different densities to obtain the effect of soil density on soil type influence on infiltration. According Halidin Primary Arfan & Abraham (2012), the value of infiltration will decrease if the slope of the land surface increases. Infiltration value will increase if the rainfall intensity increased. Infiltration value will decrease if the density of the soil increases. This study is based on the study of some of the research that has been done and the result thus obtained the novelty from literature review of studies that have been done. This study as a basis for deetemining the time of concentration on mathematical models of urban land drainage. That is the time of concentration in the timing of the concentration of urban drainage planning with environmental (eco drainage).

KEYWORD: eco drainage, infiltration, soil density, soil type

1.   INTRODUCTION

Discharge of water flowing in the earth is a modification rain that falls to the earth's surface into a discharge. The rain that falls to the earth's surface will be infiltrated into

the graund and there were melimpas above graund nevel. Factors affecting runoff divided into two groups, namely the meteorological elements and physical properties of elements (characteristics) the drainage area (Sosrodarsosno & Takeda, 1978: 135).

The influence of rainfall intesity on surface runoff is highly dependet on the rate of infiltration, surface runoff will occur in line with the increase in rainfall intesity, howefer, the increase in surface runoff is not always proportional to the increase in raifall intesity due to flooding at graud level. Rainfall intesity effect on the discharge and runoff volume.The total runoff from a rain directly related to the duration of raifall with a certain intensity.

Developmentof of a citcy demands on the local infrastructure. The level of technological development of the city also is more advenced. Urban development carried aut on land. Soil has different conditions depending on the formation of the pas and their treatment in the period running time. The procsess of the hydrological cycle is also influenced by soil conditions, namely the rain fall on the ground. Land has undergone many changens as a resulf of the traetment activities of human needs. The process of soil influence on the hydrological charactreristics is the prensence of drainage and water infiltration into the soil that affect the balance of water in the soil and on the surface on the earth'

Treatment of land for building is related to the stability bild on the land. Soil conditions that affect the calculation of the structure of the building. The structure in question is from the foundation, floors, columns, up to the roof of the building. The purposes of compancation is to increase the strebgth of the soil and omprove its carrying capacity, and reduce compressibilitas and soil perrmeability. Compaction will be implemented during the construction of a building. Changes compaction occurs when soil is compacted volume of air in teh soil pores will be reduced, so that the soil becomes more dense,the shear strength and bearing capacity increases, as well as the compressibility of the soil.

The concept of environmentally sustainable drainage (eco-drainage) requires completion with sustainable systems approach. Constraints faced by a planner is the determination of the dicharge plan. Determination of drainage discharge plan on the

concept of environmenttally sound also expected to collect rain water that falls to the ground, but can be managed and accommodated soak into the ground and continue the hydrological cycle.

2.   LITERATURE REVIEW

Precipition that falls in an area will flow on the surface of the ground as surface of runoff or get into the soil layer. According Sosrodarsono, 1993 understanding of infiltration is the process of entry of rain water into the surface layer down to the surface of the soil and ground water or ground water.

According Asdak (2002), infiltration can be defined as the process of entry into the soil as a resulf of capillry forces (water movement laterally) and gravity (water movement in the vertical direction). After a state of saturation in the uppper soil layer is exceeded, a portion of the water flowing into the deeper soil sebgai due to gravity and is known as the percolation process. Maximun rate of water movement into the soil is called infiltration capacity. Infiltration capacity occurs when the rainfall intesity exceeds the soil's ability to to absord moisture in the soil. Conversely, if the raifall intensity is less than the infiltration capacity, the infiltration rate equal to the rate of rainfall.

Surface conditions, such as pore properties and low water levels, largely determines the amount of rain water that is infiltrated and the amound of runoff. Thus. a high infiltration rate not only increases the amount of water stored in the soil for plant growth, but also reduces flooding erosion bersarnya activated be runoff. Blows rain beads on the surface of the open land destroys soil aggregates and disperse the resulting blockage of soil pores in the surface. This will decrease the rate of infiltration. The decline in the rate of infiltration can also occur due to overgrazing and soil compaction due to the use of heavy aquipment (judge, et al, 1986).

In the soil, the water was in the pore spaces between soil solids, if the ground water in the saturated state, the pore space accopied by water. In this state is called " maximum water storage capacity" ". Furthermore, if the soil is allowed to run into the drying partly filled with water. In this state the land said to be saturated (Islami and Wani, 1995).

According to (Indarto, 2010), infiltration is the movement of water down throung the soil surface into the soil profile. Based on the conceptual model of hydrologic that rain will terinterprestasikan be discharge runoff and infiltration, the infiltration will affect the amount of rain that falls to the surface teralihragamkan urban land becomes runoff discharge.

Several factors affect the rate of infiltration is soil structure, soil density, intensity of rainfall, slope, roughness of the land. Events increased the dry weigh of the load volume is called dynamic compaction. By a result of dynamic load, soil grains move closer to one another as result of reducted ais cavity. The purpose of compaction can be achieved by the selection of soil material stockpiles, compaction wasy, the selection compactor machine, and the amound of the corresponding trajectory.

Quantitavely measured soil density of the dry weigtht of the volume of soil, which is heavy or dense granularsoil oven dry weigt divided by the overall volume of the soil (ie soil volume including the volume of solid grains and pore cavity). Total soil volume (V), in general, relatively fexed by changes in water content, except on expansive clay. If as a result of changes in soil water content of the total volume (V) fixed, while the dry weight of the soil grains (Ws) also does not change, then the value of the volume of dry weight (density) $\gamma_d = W_s /V$ konstant, although the water content changes.

3. METHODS OF RESEARCH

The study was conducted with the implementation of field observations by testing the soil structure, soil density, slope of the land at the same rainfall intensity. Observations infiltration by using a Tec Turf, soil density by using a Proctor. As for the statistical analysis using experimental design and is supported by the mapping of data fields. The loop consists of several types of soil (soil structure), the intensity of rain and some slope, as well as for the carrying out of the experiment is to treat the land, namely the sensity of mild, moderate and severe.

4. ANALYSIS AND RESULTS

The process of infiltration is the process of entry of rain water through the pores of the soil surface, tertampungnya the rainwater in the soil, and the process flow of water to

another place (bottom, sides and top) though not interconnected but these three processes are interrelated (Asdak, 2002)

In the process of rain falling on the ground sparks of water, the strenght of the volume of water, is able to compress the soil surface to the water sparks close the pores of the soil. Closing of the pores of the soil will affect the face of infiltration. Treatment of soil compaction on soil structure will affect some degree of infiltration. This was stated by (Halidin Arfan, December 2012), that there is the influence of density, rainfall intensity and slope of the land to the value of the rechange (infiltration). From the experimental results in the laboratory is that the rechange value is proportional to the intensity of rainfall, the infiltration will be more in line with the rainfall. However, the value of the recharge will go down along with the dense soil, and infiltration will increase at a decreasing slope.

Soil density caused by the presence of dynamic load that occurs in the soil. Dynamic loads that can occur because there is a process of natural and man-made processes. Soil density that occurs due to natural processes usually occur on land that is not utilized as a land use. And compacting process occurs naturally due to the sparks rain, the presence of motion the earth, natural compaction of the soil due to the closure of the ground grains carried by wind and rain, and can also occur due to the natural movement of the lifting and shifting crop soil structure to pores of the soil cover each other. While the process is made by humans is due to the utilization or land use. Ground that there would be enabled to human needs. Like many urban areas in the land, the land use or land into residential use, high rise buildings and other urban facilities (shop, mall, college, etc.).

Density of land in urban areas will reduce the ability of land to absorb rainwater. The concept of environmentally sustainable urban drainage (drainage eco) functioning of urban areas to be able to manage the rainwater that falls to be back on the ground and in the ground then flows expected to be a backup groundwater or seep back into the ground and flows back into the river as the flow base (base flow).

Infiltration rate is also influenced by soil structure. The structureof land for building urban infrastructureby assensing the size of the known density of the soil. Construction of a building to make certain the soil denisty to support the soil bearing campacity. The density of the soil to absorb water from the rain water is the density of the soil that occurs at graound level on urban land.

According to (sucipto 2007), a higher density of the soil erosion, the land will be greater untill at a certain optimun poin then erosion will be reduced. This mean that then higher the density of the soil of the land, the infiltration that occurs will be smaller. Then according sucipto 2007, the intesity of 80mm / h erosion that occurs in soil test greater than the intensity of 60mm / h. This is due to the higher intensity of rainfall, the soil will receive more rain falling so that then erosion is also getting bigger. It also means that the greater the intensity of the rainfall will increase the infiltration rate.

Based on the above statement about the growing influence of the growing intensity of rain and an average slope of land against the infiltration rate, the effectof soil density on infiltration (infiltration) will have a decrease and an increase of the volue of infiltration rate different from the rainffal intensity and slope of the land is different-also vary. Because of the ability of the land to be affected by soil structure have treated soil density, respectively. So the volue of the ability of the infiltration rate will vary on soil structure and soil bulk intensity. So the infiltration rate when performed on soil structure and soil density mild, moderate, and severe with rainfall intensity and slope of the land will have the same volue infiltration different. That is solid ground, then the volue of the lower infiltration rate. And when same observations on the land with rain intensity enlarged and reduced slope , then the infiltration rate should be greater, but in this case there is the effect of soil density and soil structure. So that changes depending on the influence of soil factors.

Change the basic shape of ground can be coused by strength or carrying capacity. Change the basic shape of ground will soon change as the carraying campacity is low (ground easil collapse), development, shrinkage and densification and consolidation of subgrade soil under subgrade. These things depend on the type of soil, dry bulk density and water content (soil density). This soil is very important role in the planning or execution of the building because the land serves to support the exidting load on it.

If the urban infrastructure and has an average density is the density of the soil is the carrying capacity of land for building houses, shop and buildings, for example, the ability of urban land would also be possible to have the everage being. But if the soil bearing capacity of the soil density is high, the ability to infiltrate urban land will be low.

This connection teh influence of soil density on infiltration is to design the concept of environmentally sound urban drainage (drainage eco), in this case, if hight density, the ability to infiltrate the soil is low then the dimension of the analysis is as follows:

$$[V] = \frac{[S]}{[t]} = \frac{[L]}{[t]} \tag{1}$$

$$[t] = \frac{[V]}{[L]} \tag{2}$$

With:

[L] = [S] = dimensions of length, units of meters (m) which is the path length of the flow of water that infiltrated into the soil

[V] = dimensions velocity, unit m / s, m / h, length / time,the infiltration rate.

[t] = dimensions of time.

Low level of infiltration rate due to the influence of high soil density, but the time taken will be long. The concept of the infiltration rate can be expressed in mm / h..In a state of constant inifltrasi rate it will reach the minimum condition or critical time. With this in mind, the time derivative of the concentration will be obtained from the kinematic wave aquation that occurs in the relationship between speed, flow length, and time. Where is the critical time can be a time when the concentration reaches a constant infiltration rate. And there is a concentration that can become a reference in planning the design of the building environmentally sound urban drainage.

Planning for drainage in a city, there are many who use the conventional concept because the land is still widely available, climate change and human demands will influence land use change is still balanced (Noorvy, 2013). But now, the ratio of the population birth and death of a large population, and demand for hausing needs, facilities, infrastructures population is increasing, so the conventional conceptis no longer possible to accommodate excess water. Excess water is discharged into water bodies already have a condition that does not allow longer covered by water with slope engineering made. This is due to changes in envvironmental condition include changes in land use, climate changes, environmental policy changes, and changes in lifestyle of the people so that the carrying capacity of the environmental are already experiencing criticality.

Under the deal the world, saving the environmental which includes the soil water and air began in earnest. It is also beginning to be applied in the cities, such as surabaya and surrounding areas who have applied the concept of environmentally sustainable drainage.

Based on research (Yoon, 2009) sates that one way to determine the time of concentration for the design of hydraulic structure is the abservation in the field and finishing with the relationship between rainfall and runoff dicharge (hydrograph). Hydrograph method is by using the concept of IUH (Instanoneus unit hydrograph) or whit the concept of model clark and Nash models, these concepts becomes easier when faced with the constraints of availability of seccondary data available, especially in indonesia, which is still in the stage of completion of hydrological data collection system. Then Will, 1986, stating that the time of concentration can be done whit basic physical method using the concept of the balance of water flow (kinematic wave). The concept of this study combines the cincepts of Green Ampt infiltration models on the concept of balance of water flow (kinematic wave). Effect of infiltration is assumed to be the only loss of the rainwater that falls to the ground.Concentration time models that have been developed by chen, 2002, with a combination of a concentration of kinematic wave aquation with Darcy Weisbach equation. Chen stated that the temperature and viscosity affectthe flow time of concentration, ie with the flow is laminar, turbulent using the Reynolds number, Furthermore, studies of Tommy, in 2005, to develop

research in the study of chen before but this Tommy, rain intensity factors included in the equation of time of concentration. In 2008 by Ming-Han Li and pamaiit chibber in his research stated that the time of concentration is affected by rainfall, soil conditions, and land cover. The equation is made has included the effect of soil moisture and land cover through n (Manning coefficient value), slope and rainfall intensity,. Based on the analysis of the research that has been done, then factor that into the variable soil conditions in the equation does not include the conditions of the soll denisty.

The influence of density of soil, slope and rainfall intensity to infiltration has been done, but not until the influence of the time of concentration. The resulting concentration time on urban drainage land in indonesia is still not represented by existing equations from previous studies. Its application is made for planning the design of environmentally sustainable urban drainage.

This study aims to create a model of concentration by combining the concept of balance of water flow in the area with the concept of water loss due to infiltration The concept of infiltration that is made separately using the influence inifiltrasi rate for soil treatment. Soil treatment in this case is the density of the soil that is linked in the use of land as land use that design to avoid inundation occurs is through planning environmentally sustainable urban drainage.

Infiltration rate is also influenced by the physical condition of land that make up the type of soil, such as void ratio, soil porosity, water content, and degree of saturation. Furthermore, according to research (pratt, 2012) that the infiltration in addition affected the physical condition of the soil, is also influenced by rainfall intensity and average slope of the land. Thus, in this study, there needs to an adjustment and modification time of concentration to overcome drainage plan design with environmentally friendly concept that is by adjusting the conditions in the field. The adjustment is the physical condition of the soil-forming soil types with treatments that affect the density of the soil infiltration rate, which is then applied in a mathematical equation concentration time.

5. CONCLUTION

a. The concept of environmentally sound drainage han an important role to improve the urban hydrology. Urban in indonesia is advancing along with the

increasing number of urban population is also growing lifestyle and needs of the population.

b. Rainwater that falls on the surface of urban land management time to be back so that the rain water that falls can be reused directly or indirectly.

c. With the needs of the population will be in line with the needs of facilities, and infrastructure, it is also associated with land use that requires a strong capacity of the soil. Carrying capacity is strongly associated with the Traffic ground to soil density. The density of the soil will affect the design concept of environmentally sound drainage.

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