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INFLUENCED FACTORS OF STRUCTURE FOR WASTEWATER TREATMENT SYSTEM IN CHALLENGING AREA, (CASE STUDY: PALEMBANG CITY, SOUTH SUMATERA PROVINCE, INDONESIA)

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Abstract: Provision of sanitation system in coastal settlement is a significant problem in Indonesia. Palembang is one of the low land which influenced by the Musi river. A quarter percentage from 1.4 million of population has live either in tidal condition or above the river. This condition was caused various problems in wastewater treatment system application determination. From Information, study literature, and survey, the dominant facilities which had built were still less efficient and ineconomical, and potentially harmful to the environment as well. Therefore, design modification was needed in order to develop the wastewater domestic management facilities. (1) the effect of soil properties indicates that soil is high of water saturated and clay. Using Plaxis 8.2 2D finite element analysis, it shows the reason of crack for the structure. (2) Tidal wave, which indicated the high and low points, 1.6 m and 1.1. m respectively lead the difference between waterlogged and dry condition. It causes the problem of fiberglass floatation. (3) Water quality describes that marsh condition which had experience of aerobic and anaerobic reaction can cause the corrosion of material. From the simulation shows that crack cause because the deformation mesh values is higher than safety factor, which is $25.24.10^3$ m higher than 0.016 m. the reduction of the values cause the collapse of the building.

Keywords : Domestic wastewater treatment: specific area: deformation

INTRODUCTION

Provision of sanitation systems problems in coastal areas were unresolved problems in Indonesia, including settlements located along the river (Ida, 2012). According Djonoputro, et al. (2010), the coastal area is classified as a specific region in the provision of sanitation infrastructure, particularly waste water infrastructure due to the different conditions of the region by land area, giving rise to particular challenges in the provision of infrastructure. So far, the problem is a major obstacle in the development of sanitation systems is the lack of maintenance of existing infrastructure and the lack of integration of system design and installation of wastewater treatment in the region (Lindbo, D.2005).

Palembang is the capital city of South Sumatra Province and fourth largest city in Indonesia with an area of 400.16 km^2. Palembang is generally a quite flat area with the characteristics of the region is heavily influenced by the presence of the Musi River which divides the city of Palembang from west to east. The existence of the Musi River caused 25% of the total population of 1.4 million inhabitants live in the city of Palembang in areas above the tidal marsh and river Musi (Djonoputro et al, 2010). The swamp area has unstable soil with a high water table and is influenced by tidal waters so we need a sanitation facility in accordance with the characteristics of the region of Palembang.

There are still many obstacles that hinder the government's ability to provide wastewater treatment systems as well as ongoing maintanance system. One of the failures

caused by factors of community acceptance. In addition, the problem posed is a discrepancy existing sanitation system design with regional characteristics of Palembang. Results of the study Djonoputro, et al., (2010) which states that the condition of the region of Palembang in the form of the marshland which cause a variety of problems in determining the application of the waste water treatment system of domestic waste.

Based on this, it needs a fursther research to defined the sanitation system in Palembang region. As for the factors that affect the infrastructure that were examined in this study are soil characteristics of the study area which is marshland, tidal river, and the river water quality affecting the design of treatment facilities sewerage system.

METHODOLOGIES

This research is focus with influenced factor of structure stability in domestic wastewater treatment. There are three stages of this research, which are; Research Preparation, Data Collection, and Data Analysis.

Research Preparation

In this phase is to determine the object of study, source of data, sampling techniques and analytical methods. Location of the study area is shown in **Figure 1** shows the location of the study area.

Palembang city was selected as a site of research. This location was chosen based on the condition of a residential community, which is a region of rivers and swamps in Indonesia. Palembang is the capital city of South Sumatra province and the fourth largest city in Indonesia. Palembang in general is an area with a sloping terrain that is geographically divided into two by the river Musi area and Seberang Ulu Seberang Ilir is a lowland region affected puddles (Siswanto, 2009). The presence of the river Musi cause 25% of the population living in the area of Palembang tidal marsh and over the river Musi (Djonoputro et al, 2010).

Foccused sites were in four district in Palembang city. These areas are as follows; Sub-District 1 Ulu, 2 ulu, 3-4 Ulu, and kelurahan Tuan Kentang. The region covers an area close to the banks of inland rivers and swamps (swamps, swampy), but the equation of state of this area is all the areas adjacent to the Musi River which children are affected by Tidal seawater.

Pengumpulan Data

The data collection was consisted of two types, namely primary data and secondary data. The secondary data in the form of public data (archives, libraries, reports, journals, technical instructions).

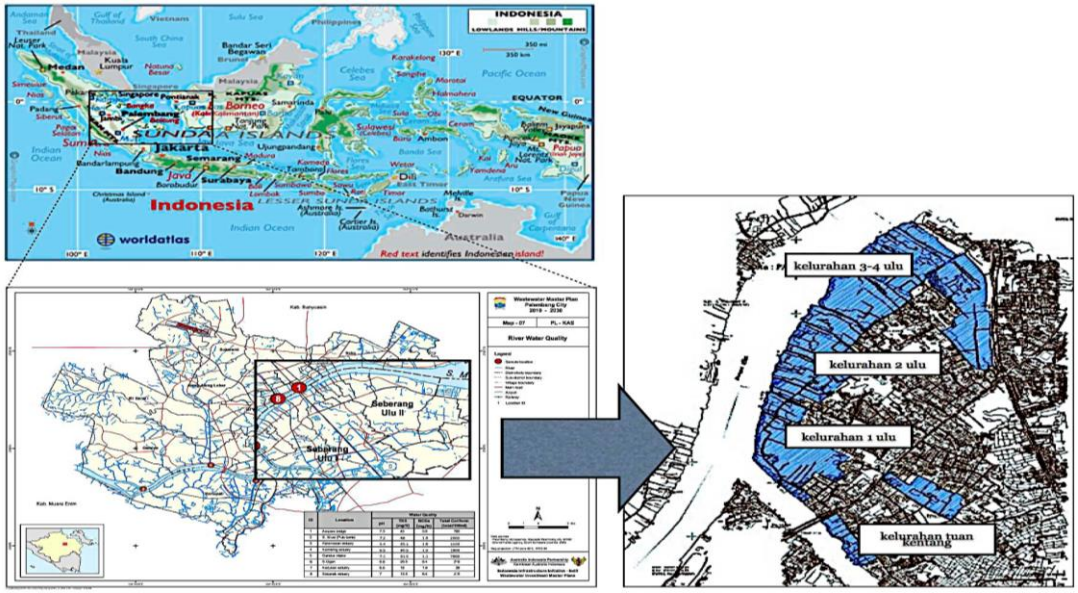


Figure 1. Research location**.**

For Primary Data, consists of field observations conducted in conjunction with ongoing research, graduate student of Faculty of Civil and Environmental Engineering, Bandung Institute of Technology, **Arti Indallah.** The first observations were made at the beginning of the study is that a sanitation inspection latrine facilities, means of disposal of domestic wastewater, and waste disposal proposition society, followed by a look at the desire of the community to sanitation facilities.

Field observations were carried out is to look at the condition of the existing infrastructure of existing effluent water in the study area. The next technical data collection is by sampling marshland sondir manner and boring logs. Soil sampling by boring logs, using the general method of ASTM D 4700 methods of augering, drilling & Site Investigation, This is done to obtain the data of physical and chemical properties of the soil. In the testing ground, the thing done is the determination of the location of the sampling by using purposive sampling method. Method of data collection is done by considering certain things that are considered to represent the observed region. So as to facilitate a team of surveyors to explore the situation of the study sites. Terms of soil testing itself must look at the characteristics of the soil in order to meet the region preventative area observed at each level of density level.

Data Analysis

Data analysis is the process of searching and compiling the systematic data obtained from interviews, field notes, and documentation (Sugiyono, 2008). By way of organizing the data into categories, lays into the units, synthesize, organize into a pattern, and then choose which ones are important and which will be studied, and make conclusions so easily understood by myself and others.

This research was carried out in abundance descriptive, that is an analysis that is based on data obtained inductively developed into a hypothesis. The data have been obtained later recapitulated by using Microsoft excel. It is focused on the research is only in its existing

state of sanitation in the study area. In parallel, a review of soil samples in the laboratory to see the characteristics of the soil.

Followed by simulating the model waste water facility with the character of the soil tested. The output of this software is to see how the study of land subsidence due to load upper load. Having obtained the results of further analysis of the problems that occur with domestic waste facility.

RESULTS AND DISCUSSION

Existing Condition of Domestic Wastewater Treatment Facility

Conditions of sanitation facilities especially wastewater treatment facilities should be studied to know the habits of the community in the study area as a material consideration in choosing sanitation technologies.

Knowing Existing Condition is very necessary to look at the toilet preferences used by the community **Figure 2.**

Figure 2. Type of used toilet (a) Hole in the floor (b) Fabricated toilet with broken flush (c) fabricated with good system.

Table 1. It can be seen that there are many people on both the type of home that inadequate infrastructure and technology. However it can be seen that the type of public house on stilts situation better than the people at home are still conventional floating. This is done because it is difficult to build adequate wastewater infrastructure over the water

Table 1. Toilet Condition and Treatment in community.

Variable	Semi-permanent House		Floating House	
	Frequency	%	Frequency	%
Type of Toilet				
Private Toilet WC	162	68.1	11	61.1
Sharing toilet	13	5.5	0	0.0
Public Toilet	48	20.2	1	5.6
River/drainage	15	6.3	6	33.3
Variable	**Semi-permanent House**		**Floating House**	
	Frequency	**%**	**Frequency**	**%**
Shape of Toilet				
Hole in the house floor	76	31.9	12	66.7
Seat Toilet	0	0.0	0	0.0
Squatting Toilet with broken flush	66	27.7	0	0.0
Fabricated Squating toilet	84	35.3	0	0.0
River	12	5.0	6	33.3

Wastewater Treatment				
Pit latrine	39	16.3	0	0
Drum in land floor	21	8.8	0	0
Direct pipe	10	4.2	0	0
Brick septic tank	27	11.3	0	0
Fabricated septic tank	21	8.8	0	0
Recharge into communal system	0	0.0	0	0
No treatment, no pipe	110	46.0	18	100
No treatment, pipe direct to the river	10	4.2	0	0

*) on going research

It can be seen from **table 1** Community in the study area still using squat toilet. It is important to note that different because society allows different preferences depending on the local culture and customs. This indicates the vulnerability of sewage contamination of the Musi river in the area itself, from field observations were carried out, the design of the septic tank itself also does not follow the standards that have been set Indonesian National Standard (SNI).

Failures that occur in domestic wastewater treatment facility

As mentioned before, Viewing from existing conditions that occur there are several types of existing treatment systems, directly in the exhaust system in the river, squat toilets manufactured with goose neck, squat toilets manufactured in olongi, toilet seat, and a hole in the floor house. However, almost all types of domestic septic tank waste management. Septic tank in this case is assumed to be a good system even though there is a system of communal and ABR to the biofilter tank in the area of research. Existing management systems will be references in the design of future innovation. Settlements in the study area is dominated by residential with type stage with some of them are floating homes on the flooded area (river area). In addition, there are areas of land reclamation on the type. In general, people use river water for daily needs. Wastewater facilities owned by communities dominated by pit latrines without management systems. Some people use local materials as waste shelters, such as PVC pipes, drums, with the form of columns made of brick or concrete. In addition to the individual facilities, there is also a public toilet facilities were built, both by the community and government. In the new residential area reclaimed in accordance with the government program, individual toilets are provided, including a simple exhaust system for the wastewater treatment facility. The conditions of settlement and sanitation facilities is shown in **Figure 3.**

Most of the application of the wastewater treatment system by the government or private parties is a facility that is commonly used in the area of land types. Of the many facilities that have been observed in this study, there are three problems that often occur, the cracks in domestic wastewater treatment, flotation of fiberglass on the bottom inside the protective wall construction, and pipe connections are broken.

Effect of Land Characteristics

From two points of soil sampling locations, indicate the location of the land in the area to take the characteristics of the soil samples showed that the soil is saturated with water and is classified as a medium plastic inorganic clays. Research sites have ground water elevation and is influenced by tidal sea level. Groundwater levels above 50 cm - 60 cm This indicates

that this region is quite high for flooded. Figure 4 shows that the greater the resistance value or qc states that land closer to the ground hard. In the following soil tests can be seen that the ground is still soft around the value of 5.4 m while to get to the hard ground around a depth of 6.6 m onwards

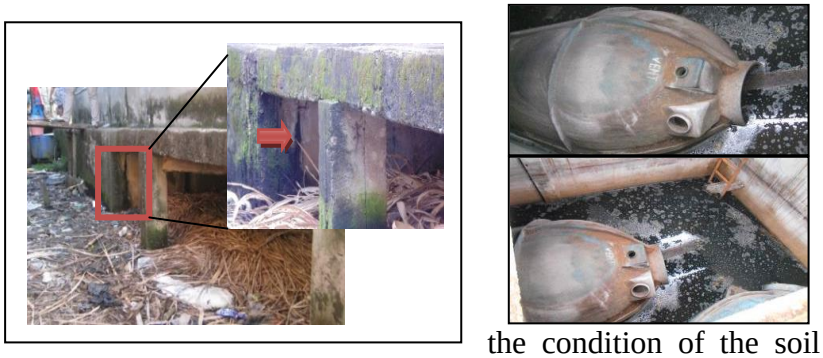
Seeing  the condition of the soil is relatively

Figure 3. a) Cracks in concrete material b) Flying Biofilter.

stagnant construction is required in accordance with the conditions of the soil itself. The rupture of sewage treatment and the frequent occurrence of a fault in the system piping may occur because of differences in the value of deformation of construction toilet with treatment system. Value of soil characteristics can be seen in **Table 2.**

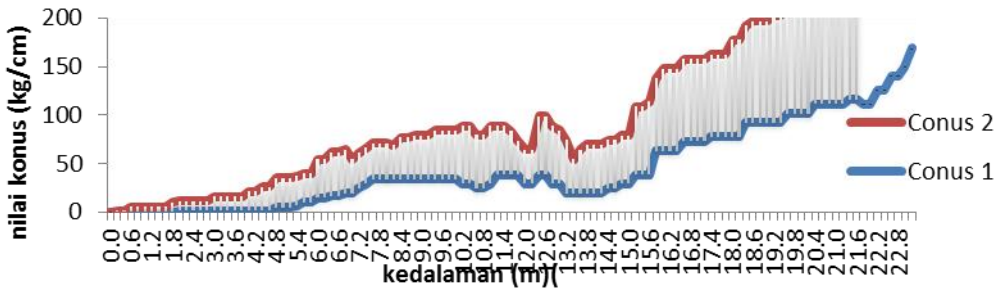


Figure 4. SPT graph.

The water content is almost close to the value of 100% indicates that the water content in soil is very high so do not be surprised if the ground is fairly soft. In general, for coarse-grained soil (coarse-grained), the nature and degree of the relative density of the particles is very important, consistency and plasticity of the tested soil showed that the soil including soft soil with the index value of the plastic is still in the value 7:23% and 15:50%.

Table 2. The characteristic of Soil in research site.

Tanah	Units	Tabung B1	Tabung B2
Berat Jenis tanah	gr/cm^2	1.42	1.42
Kadar Air (w)	%	170.29	93.84
Specific Gravity (Gs)		2.64	2.63
Batas *Atterberg*			
LL	%	50.10	59.70

Tanah	Units	Tabung B1	Tabung B2
PL	%	42.87	44.20
PI	%	7.23	15.50
Analisa saringan			
No. 3/8	%	100.00	100.00
No. 4	%	100.00	100.00
No. 10	%	99.71	100.00
No. 20	%	98.86	99.67
No. 40	%	98.43	99.00
No. 60	%	98.00	98.83
No. 100	%	97.71	98.17
No. 200	%	96.57	95.33
Pan	%	0.00	0.00
Konsolidasi			
Cc		0.52	0.51
Cv	Cm^2/min	0.00	0.00
Triaxial			
Φ		2.40	0.00
Cu	Cm^2/min	0.05	0.10

Cv values on soil properties provide information about the time required for a decrease (depression) were simulated using Plaxis. Simulations show that the time required for the overall decline is 100 times the emphasis by the load. This gave the need for preloading information requirements to achieve a certain reduction in order to reach stable ground. Cu values are under 0.25 tones / m so that the land is categorized as soft ground.

In this study, two modeling systems for the option selected, the watery pit latrine (Privy aqua) and Communal septic tank. The building structure is simulated using septic tanks and aqua Privy using concrete materials. It is assumed that the fiber material is much lighter than concrete. The capacity of each treatment was 5 people. From the results of the test with PLAXIS, deformation values issued by the Privy aqua and septic tanks are as follows 854.92 x 10-6m (Figure 6b) is 25,24x10-3m (Figure 6c). Previously conducted testing on the safe point with no load in it. Logically rift would not have been possible in a short time due to a considerable reduction of small value.. Then gradually with the addition of a load on the processing of domestic waste can affect the soil and decrease the load on the shear strength of the foundation itself. It is also the same as the pipe breakage in domestic wastewater treatment systems. This is because of differences in the toilet with a decrease in domestic wastewater treatment. .

Figure 6 shows a tendency toward collapse quite scattered. These conditions increase the probability of collapse of different directions in a structure that increases the likelihood of cracks. Information security factor (safety factor) obtained figures show 2.05 m which is very close to the standard values are allowed (2.0 m). Although it can be classified as safe, with a slight increase in weight of the structure can lead to excess deformation. In an effort to prevent this, the addition of an effective foundation needed (Ddarjanto, 2004)

In principle, if the load is excessive, failure usually occurs in the form of shear failure.

So in fact the main structural strength is a function of the shear strength. Soil shear strength in any direction is the maximum shear stress that can be deployed into the structure of the soil in that direction. At the time of reaching the maximum value of shear stress, the soil is considered to have failed, the shear strength mobilized telag entirely.

Shallow stabilization technique has limitations in the application of this technique is that it is not intended to eliminate the overall decline, but only serves as a far decrease (DPU 2005)

The presence of other causes of failure were not taken into account other than perhaps as a result of poor construction workmanship and details that less attention system. Detection of unexpected behavior during the excavation process can only be done by monitoring the performance of the process of beginning to end. An effective performance monitoring program should be included in the design for a variety of excavation in which the consequences of the predicted movement is significantly greater (Marr et al, 2007).

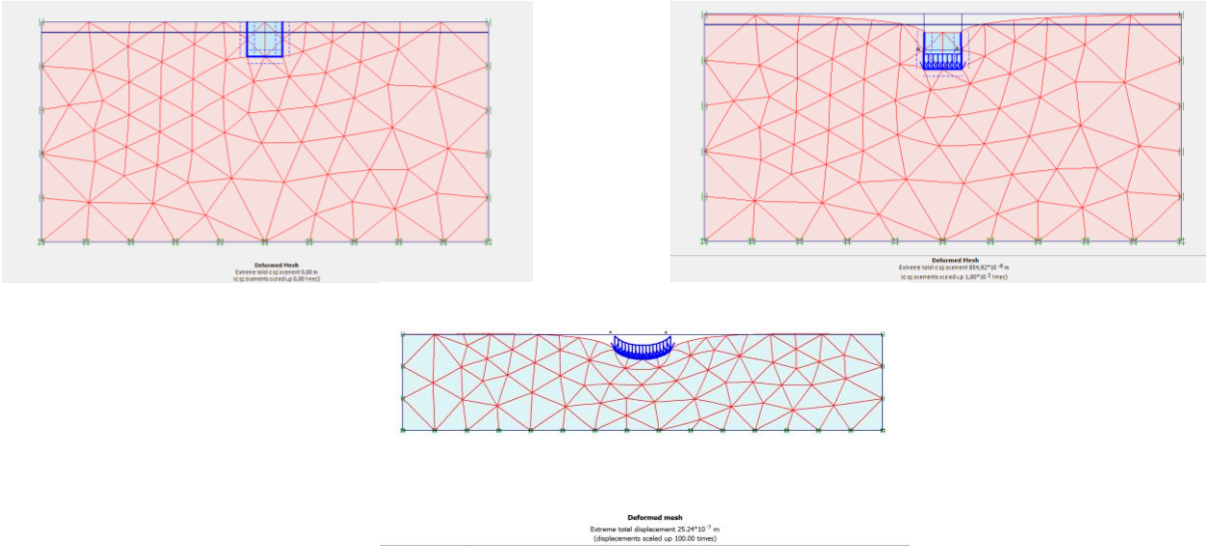


Figure 6. (a) *Deformation mesh in safety condition (b) deformation mesh* in *Aqua privy system; (c) deformation mesh communal septic tank system.*

Tidal Waves Effect

The study area is influenced by the tidal wave of water. Figure 7menunjukkan highest tidal elevation within one year occurred in January. In Figure 7, the level of water table changes with a high point occurs at the rate of 1.6 m above ground level, and the low point occurred at the rate of 1.1 m below ground level. This led to the residential areas have flooded periods and dry periods.

Stagnant periods and dry periods to explain the cause of the problem of fiberglass flotation of wastewater treatment systems. This is caused when the water reaches the water treatment system, Archimedes law applies (Sumidjan, 2012). According to the law of Archimedes, buoyant force balanced and opposite to the weight of displaced fluid (Lautrup, 2005). Wastewater treatment systems. If, waste water treatment system is made of very light material, the average density of the air in the fiberglass tank will be lower than the density of

water so that moving the system into a floating and detached from other supporting material. It is recommended to fill the fiberglass wastewater treatment system with water until full when placing the tank is empty, but still have to pay attention to the style of the riverbed processing system (or a layer of fiber glass construction below).

The quality of water contained in the marshland, Dealing with the effect of tidal wave river water which has been described previously, marshland aerobic and anaerobic reactions that explain the occurrence of corrosion in wastewater treatment systems (Figure 5). Corrosion problems caused material is slowly destroyed. Corrosively will also affect the strength of concrete (Sulistyoweni, et al., 2002). Immersion test shows the speed of corrosion of concrete (strength ST 37) are periodically soaked in water swamp (which comes from the swamp area of Jakarta) is 14,467 mpy (mille-inches per year). This value is three times higher than that of concrete continuously soaked with swamp water (5.098 mpy). Corrosion problems also contributed to the decrease in concrete strength also cause cracking problems in the water treatment facility with concrete materials. Ghani (2006) also mentions that the groundwater level changes also provide long-term impacts associated with a reduction in force or reduction in capacity.

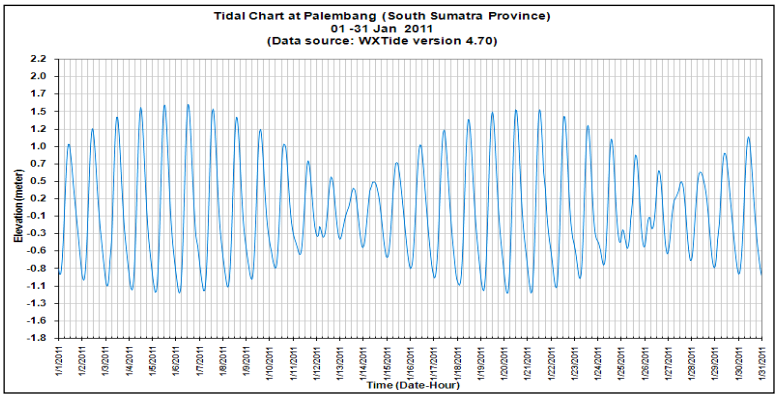


Figure 7. Gelombang pasang surut dan perubahan tabel air di kota Palembang pada januari 2011 (Source : Universitas Sriwijaya).

Alternative Solutions for Domestic Waste Management Structure

From the previous explanation, People who live in houses on stilts, wear as much as 16.3% and 11.3% use a pit latrine cesspool, the rest use other types of processing. Followed by a floating society no one is using domestic wastewater treatment systems. It should be considered in the development of domestic sewage treatment in the area of the swamp is the way How can create an efficient technology to last long. Stages in the life of the community utilizing sanitation facilities is still quite low. Society still considers that the septic tank and the other type is a collection of faeces. So in the selection of technology options, should pay attention to the technical aspects of building the facility itself. Requirements to build this facility itself should avoid systems that are not good for areas with high ground water level as septic tanks. Then the material is susceptible to corrosion. So if in doing studies didapatlah decisions that result in the efficient processing for the watery swamp is latrine by using fiber material modifications. Figure 8 Displaying modfikasi plan design in swampy areas

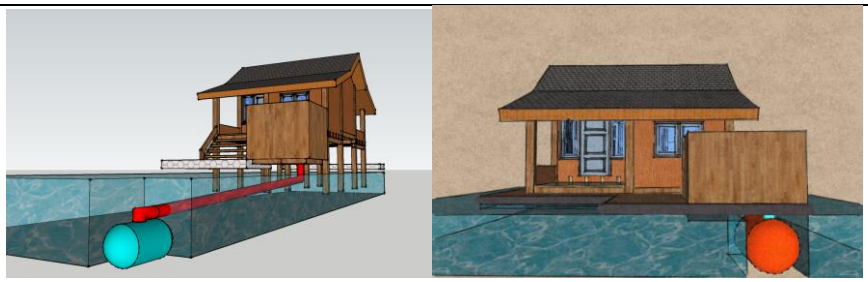


Figure 8. Ilustrasi Modifikasi Desain Sistem Pengolahan pada Daerah Rawa.

To overcome the problem of flotation devices due to water pressure and tidal wave, if you want to use septic tank fabrication or biofilters, Where the pavement foundation raised if such a device it would be difficult and damaging treatment. In addition, it is advisable to fill up water treatment system with full advance when placing the tank is empty. For a floating house, it must be added a cover to protect the movement of the processing system itself.

CONCLUSION

The community in swampy area, 16.7% and 11.3% still use the pit latrine and septic tanks. It necessary to repair the domestic wastewater treatment based on people's habit. But the problems were occur in domestic wastewater treatment system, e.q cracks in concrete masonry wall that exceed of deformation limit.. It is also supported by the movement of the tide influences. The highest up sea level was in 1.6 m and following 1.1 m as the lowest level. Modeling is done by simulating the soil loading Privy aqua system and septic tanks with the help of software PLAXIS 8.2 deformation values issued by the Privy aqua and septic tanks are as follows 854.92 x 10-6m 25,24x10-3m. From references, references, it is concluded that it is time to develop the appropriate technology such as tripikon-s and modification of aqua Privy materials using fiberglass in swampy areas.

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