

## **BIOPORE: VERTICAL CEMETERY OF MUSLIM SOCIETY IN SURABAYA**

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## ABSTRACT

Urban density causes various problems in big cities in Indonesia, including Surabaya. One of that is the high death rate of population each year, which led to the more limited cemetery land. The burgeoning demand for the need of cemetery land, especially the demand of cemetery land for muslims, is increasing. Cemetery land which cannot be expanded eventually implement the stack system. Stack system can only be done if the family of the dead which is buried in the grave permit the stacking. Referring to stack system, vertical cemetery might be right solution to overcome the problem of limited cemetery land. The research method used is qualitative method to gain the criteria of plan. Biopore concept is adopted related to ecological architecture as a design approach to explore the form of cemetery. The goals of this research is aimed to get the design of vertical cemetery for muslims in Surabaya.

**Keywords:** Cemetery, vertical cemetery, stack system, biopore

## 1. INTRODUCTION

Surabaya, as one of the major cities in Indonesia, has a problem of urban density. The increase of the number of people each year gives a direct impact on the urban environment in Surabaya. It is seen from the decreasing availability of vacant land in urban areas and green spaces which are transformed to housing and settlement. The high rate of population growth also affects the high death rate. It leads to high demands of cemetery land, especially cemetery land for muslims.

Most of the population in Surabaya is muslims, and indirectly it contributes to the highest death rate among other religions. The death rate of the population is very high, but the number cemetery lands which are available is getting fewer. Some Public Cemetery (TPU) in Surabaya have been full, and it is worried that in the next 10 years Surabaya does not have any empty graveyard. Currently, the Government of Surabaya offers a solution for burial grounds which have been with the stack system. But the stack system can only be done on the old cemetery which had been outstanding for more than decades. There are also graves that have not been aged decades but stack system is implemented in those graves due to the demand of the family. As a result, there are 2 to 4 bodies in a grave from the same family.

The stack system has weaknesses in its application because it can only be applied to the old graves which are decades old if the body which would be buried is not from the same family. The implementation of the stack system is also not planned from the beginning, therefore the excavation

pit for a new body to be buried is shallower so there will be a risk that the stench will come out of the grave.

The expansion of the graveyard has been done by the Government of Surabaya on two new public cemetery (TPU), which are TPU Keputih and TPU Babat Jerawat. But the process is slow due to the constrain of availability of vacantland and the expensive land. TPU Keputih will be the location of the research to develop the vertical cemetery because TPU Keputih has so much vacant land, and TPU Keputih also has the widest cemetery land compared to TPU Babat Jerawat.

In Islam, funeral requires on the ground, according to the rules of burial in Islam. In the translation of the Qur'an (QS.20. Thaahaa: 55 and QS.71. Nuh: 18), it is clear that the funeral for Muslims should be in land. In a hadith Muslim 970, there are three things which are prohibited in the Islamic cemetery, which are the prohibition of brickwork (harden), sitting on the grave, and make buildings above the grave. The surah Al -Qur'an and the hadith above will be used as theoretical basis of the research of vertical cemetery design, which is in accordance with Islamic Shari'ah.

Cemetery in land in Islam has been linked to soil ecology, which is where body is decomposed by soil microorganisms. The development of graves into vertical grave will affect the soil ecology directly. Therefore, the development of graves to be vertical graves requires design approach of ecological architecture (eco-architecture) which is environment oriented, which utilizes the natural potential. One potential which is utilized is the microorganisms in the soil that play a role in decomposing corpse. Increasing the activity of soil microorganisms in the decomposition process can be done by biopore infiltration hole method. Biopore is a water catchment method which is aimed to overcome the puddle by increasing the absorbing power on the ground (Kamir R. Brata, 2008). Therefore, biopore will be used as the main concept in vertical cemetery design related to composing the body.

## **2. THEORETICAL REVIEW**

### **2.1 Ecology and Eco-Architecture**

Ecology is usually understood as the things that influence each other or the mutual relationship of all kinds of living things (plants, animals, humans) and the environment (light, temperature, precipitation, humidity, topography, etc.). Ecology comes from the Greek word, *oikos* which means house and *logos* which means science, so ecology literally means the science about household of

living things (Yeang, 1995). Definition of ecology according to Otto Soemarwoto is “knowledge about the mutual relationships between the living things and the environment” (Hardjasoemantri, 1996).

Attention toward architecture as engineering science is transferred to the humanitarian architecture that also takes into account the harmony with nature and human interests as inhabitants. Construction of houses or residence as a necessity of human life in a mutual relationship with the natural environment is called ecological architecture or eco-architecture. Eco-architecture does not determine what should happen in an architecture because there is no binding characteristic as standard and including the harmony between man and his environment (Frick, 1998).

## 2.2 Biopore

Biopore are holes in the ground which are formed by the activity of organisms therein, such as worms, plant roots, termites and other soil fauna. The holes which are formed will be filled with air, and it will be the passage of water in the soil (TIM Biopori IPB, 2007). Biopore holes in the ground can be created by making biopore infiltration holes. Biopore infiltration hole is cylindrical hole which is made vertical into the ground with a diameter of 10 cm and a depth of 100 cm. In the case of shallow surface of groundwater, it does not exceed the depth of the face of ground water (TIM Biopori IPB, 2007). The cylinder hole is filled with organic waste to feed the soil fauna, known as soil microorganisms, which in turn is able to create pores in the soil.

Biopore has ecological and environmental benefits, which increase the absorption of ground water, organic waste management, and enhance the activity of microorganisms for soil health. The more active, the soil microorganisms multiply rapidly and can accelerate the decomposition of organic elements. Biopore is a new concept which has been adopted into the landscape architecture as a complement to the park that implements the concept of green house (*Badan Lingkungan Hidup Kabupaten Bantul*, 2014). Biopore plays a role in restructuring the soil of an artificial environment which is designed by an architect, therefore biopore can be applied as a concept in the design.

## 2.3 Funeral in Islam

In Islam, there has set procedures for the burial of the bodies which are based on Qur'an, hadiths, and postulates. In Qur'an, Allah says in Surah Thaahaa and Nuh:  
“From the earth (ground) We have made you and to Him, We will bring you back and from it We will release you at other time” (QS.20. Thaahaa:55).

”Then He returns you into the ground and release you (thereof on the doomsday) truthfully” (QS.71. Nuh:18).

Both surah above explain that man was created from the ground and had to return to the land anyway, and indirectly explain the cemetery for Muslims that should be in the ground.

Islam prohibited building grave like brick building (harden), sat on the grave, and even build a building on the cemetery. The ban was narrated by Imam Muslim *rahimahullah* from Jabir *radhiallahu’ anhu*: “And for Muslims from Jabir, ”*Rasulullah Shallallahu Alaihi wa Sallam prohibit brick grave, sit on it and build on it*”” (Ash-Shan'ani, 2007).

### 3. DESIGN METHOD

In the early stage of data collection, the process of this design study uses qualitative methods, which try to interpret phenomena, perceptions and thoughts (Groat & Wang, 2002). Qualitative method used are interviews and observations (Groat & Wang, 2002). Interviews method is used to collect information directly from the chaplain or people who are experts in Islamic law. Observations method is used to observe and collect the data about the existing condition of the land. Both methods are used to obtain the criteria of the funeral design. In data collection, it also uses the literature method that refers to Qur'an, the Fiqih book, and other books which become the review of this research. Design by analogy method (Broadbent, 1973) is used to get the form of the funeral, which analogize forms and elements of biopore in the form of a vertical cemetery. Form of the presentation of results as the end of this research is schematic design.

### 4. CRITERIA OF DESIGN

The main concept which is used in the design of vertical cemetery is biopore. Based on the analysis of the first data by using qualitative method, then the criteria of design which is resulted are as follows:

- Burial on the land that applies the principles of decomposition, and can increase the activity of soil microorganisms and accelerate the decomposition process.
- The depth of the grave pit minimum of 1 - 1.5 meter. The depth of the hole does not make the process of entering the body into the grave difficult.
- The grave is not hardened by concrete, without a roof/ shade/ building above the grave.
- Landfill which is made vertical, there is soil sanitation in advance by including microorganisms and organic elements before it is ready to use for a funeral.

- Make a landfill which is higher than the original land surface. The landfill should be hardened on the edge so that the soil does not get carried away by landslides or water during a flood.
- Do not use the big sized plants.
- Select a location which is not passed by *Ring Road*.
- Using the method of infiltration that can store water supplies and can maintain soil moisture.
- Plan the orientation of vertical grave toward the direction of Qibla.
- The design of the vertical cemetery follows the Local Regulation of Surabaya.

## 5. ANALYSIS OF DESIGN

This research is aimed to produce the design of vertical cemetery which can overcome the problem of the limited cemetery land for Muslims. Below is the result of analysis in producing vertical cemetery for muslims.

### 5.1 The Need of Cemetery Land

Planning of the vertical cemetery for Muslims requires lots of planning of grave hole, the main circulation area, and the service circulation area. Standard of the area of the main circulation and service is equated, it is intended that the circulation area of the service can be used as an incidental circulation during a crowded at the main circulation. Dimension and the area of a plot of grave have been arranged in "Local Regulation of Surabaya City No. 13 of 2003 about the Management of Cemetery and Organization of the Funeral of corpse". This rule also contains technical rules regarding the cemetery in the Surabaya city.

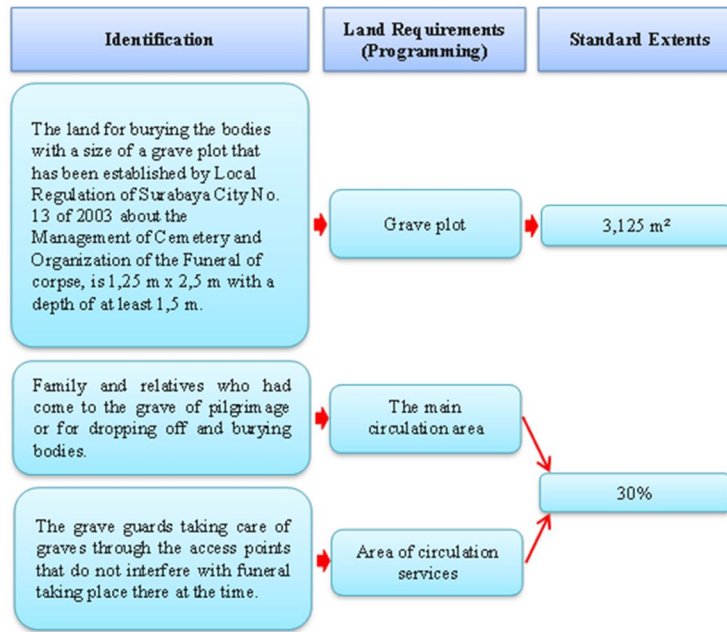


Figure 1. Analytical scheme of land requirements

### 5.2 Topografi

Currently, TPU Keputih has a total area of ± 35.5 hectares with the status of land owned by the government of Surabaya. Government of Surabaya City is doing land filling on the ponds that have been released and these lands will be used for future expansion of the cemetery.



Figure 2. (Left) Existing block of TPU Keputih; (Right) Location of land for vertical development

### 5.3 Orientation

Dimensional and form of graves had been set on the Local Regulation of Surabaya. Grave without pavement is related to the background of grave as the former of the ecological space of the city, which is as Green Open Space (RTH). Related to the orientation of the grave, Qibla direction

of Muslims in Indonesia is located in the west of compass. Qiblah direction for Muslims is applied for the living and the dead. The grave position for Islamic cemetery is located on the west side of pit grave with the body facing towards Qibla (west), so the orientation of the Muslims' grave is facing south with a position of the headstone on the north side.

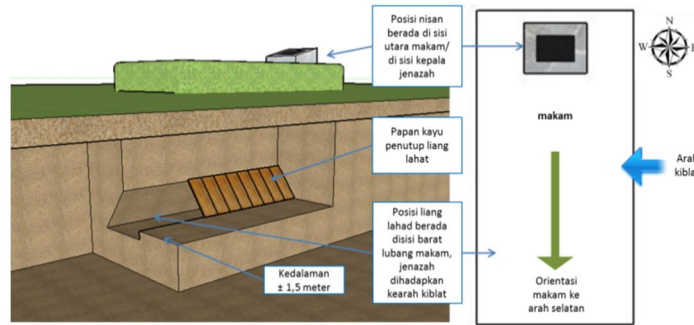


Figure 3. The Graves of Muslims according to the Local Regulation of Surabaya City

### 5.4 Basic Shape

Analysis of the basic geometric shapes is aimed to get the basic shape that can use the land efficiently. The basic shape which is selected for the settlement of layout blocks of grave under the consideration according to D.K Ching (2007) is basic rectangular shape.

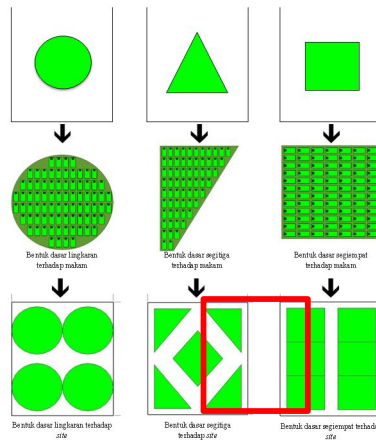


Figure 4. Analysis of the form of the layout block of grave

## 6. RESULT OF DESIGN

This study is aimed to produce a design of vertical cemetery that is able to overcome the problem of limited burial ground for Muslims. Here are the results of analysis in the process of producing the design of vertical cemetery for muslims.



## 6.1 Cemetery Shape

### 6.1.1 Cemetery Block

The shape of cemetery block is based on the analysis of basic forms and shapes of the land. The shape of cemetery block is the result of the analogy of biopore form which is transformed vertically upwards for elevation manufacturing. Elevation manufacturing of cemetery block is associated to the condition of the existing land which often floods.

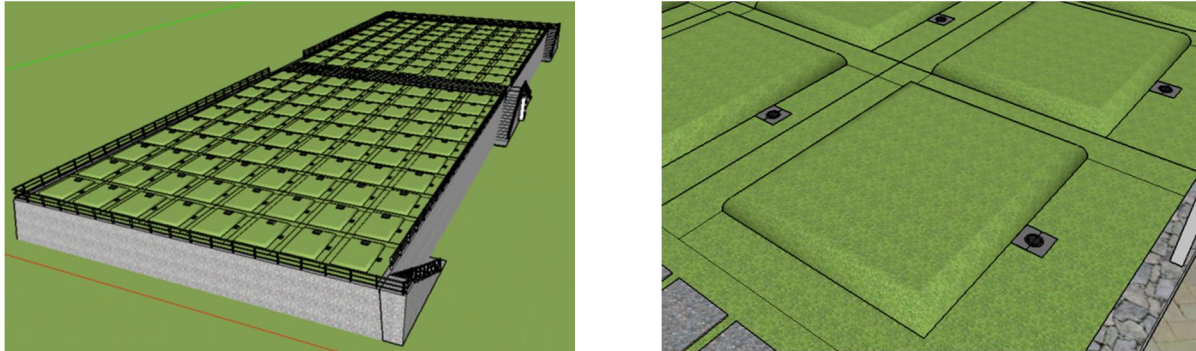


Figure 5. (Left) The design of vertical cemetery blok; (Right) the cemetery plot which is still empty

The design of the vertical grave block consists of provided cemetery plots which is 6.9 m<sup>2</sup> and made up ground elevation as high as 20 cm. Cemetery plot that has not been filled with corpse without headstone on the grave. The area of this grave plot is larger than the dimension area of the grave plot which is specified in Article 4 in the Local Regulation No. 13 of 2003 because of the manufacturing of grave basement.

### 6.1.2 Cemetery

The shape of grave is also a result of the transfer analogy of the form of biopore infiltration hole, thus it forms the basement. The basement manufacturing was intended so that the grave diggers do not have to dig as deep as 4.3 meters every time they want to bury the dead. Grave digger only have to dig as deep as 70 cm, and then lift the concrete of grave cover using a portable crane. Basement is designed not up to the ground level so that the families and relatives who bury the dead can sow the soil three times in accordance with Islamic Shari'ah.

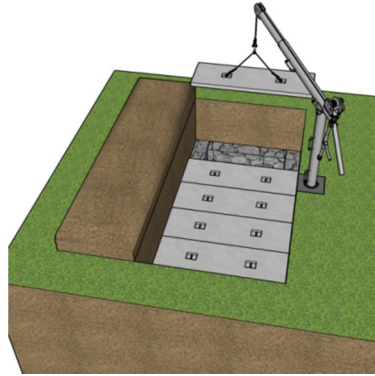


Figure 6. Slab concrete of basement grave cover

### 6.1.3 Cemetery Basement

Each grave consists of five grave pits which are found on the basement walls of the grave. The wall of cemetery basement is build of mountain stones/ river stones which are arranged and tied with wiremesh, to create cavities between the stone that are served as biopore. These pores deliver nitrates which are produced by the nitrivitor bacteria into the ground and into the air. Nitrate which is produced is derived from the decomposition of ammonia compounds from the bodies. Ammonia compounds are very harmful to the human body, especially if it is inhaled by people who bury the dead. Therefore, in the basement of the grave, bacteria nitrivitor is given on the ground after the wooden boards, the cover of the grave, to convert ammonia into nitrate . Nitrate compounds can also be dissolved and drifted with groundwater. Biopori infiltration holes in the bottom of the basement grave is aimed to absorb water into the basement of the grave. The basement floor of the grave consists of mountain/ river rocks which is arranged and bound with wiremesh, thus it forms cavities to absorb water which then goes into the biopore infiltration holes.

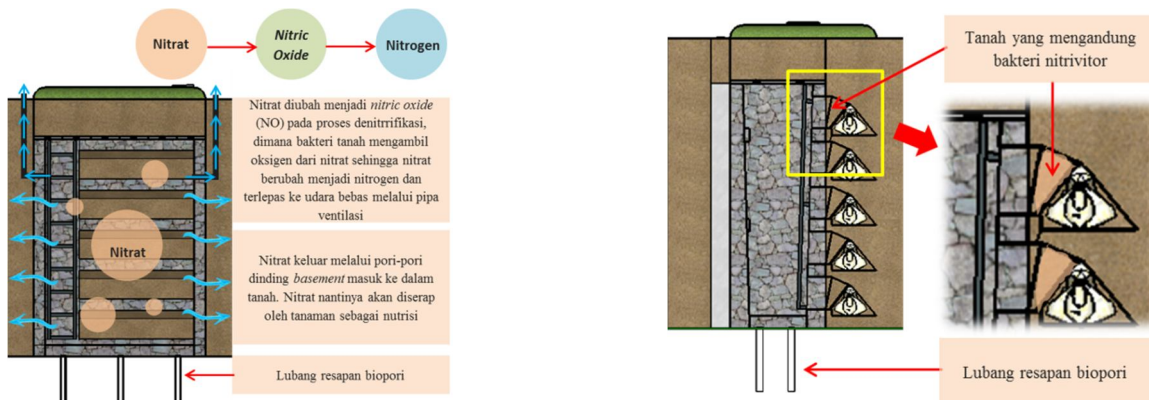


Figure 7. (Left) The process of release of nitrates in the basement; (Right) Placement of nitrivitor bacteria

### 6.1.4 Distance between Graves

Related to the distance between graves had been arranged on Article 5 of the Local Regulation No. 13 of 2003 is 50 cm on each side of the grave that is served as circulation. But in the result of design, the distance between the graves on the left and right is 100 cm. The addition of the distance is as space for portable crane assembling and for storage of the concrete slab of grave cover. The distance between graves in the side of the head and foot of the grave remains 50 cm in accordance with Local Regulation No. 13 of 2003.

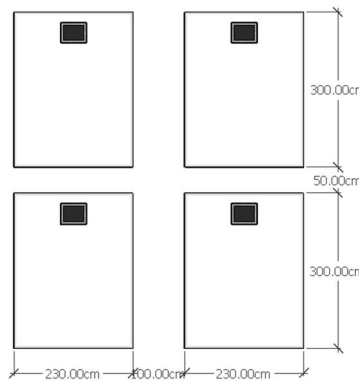


Figure 8. Design of distance between graves

## 6.2 Site Design

### 6.2.1 Master Plan

The design of the vertical cemetery for Muslims is using the concept of future development related to the considerations of *Ring Road* which cross the grave in the future. The land for the vertical cemetery of Muslims is chosen from the land that is planned for Islamic cemetery block.

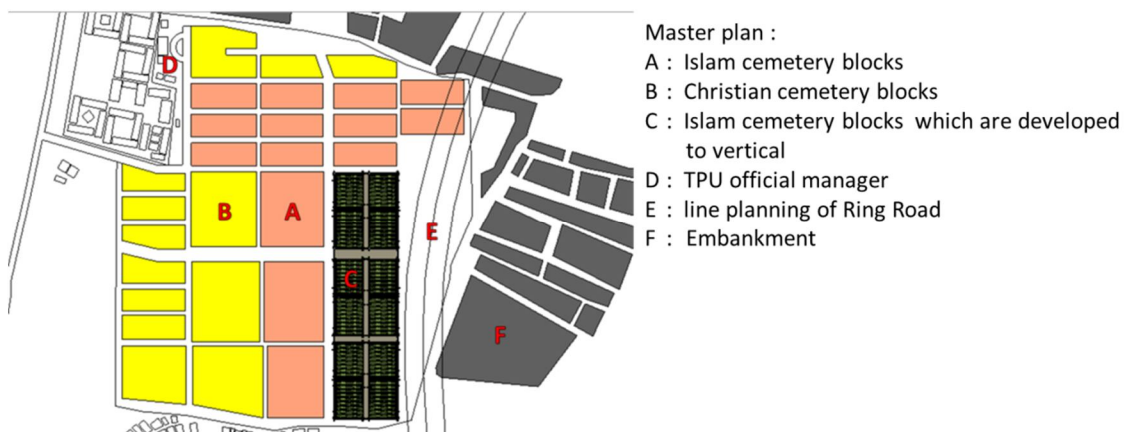


Figure 9. Master plan

### 6.2.2 Vehicle Circulation

Design of ramp as the access point and the circulation to the grave. The slope of the ramp is about  $\pm 5^\circ$  so that it is not too steep for the convenience of users.

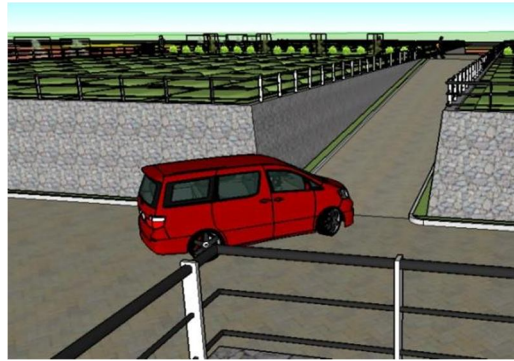


Figure 10. Ramp

### 6.2.3 Circulation Path of Graveyard Block

The main circulation path on the graveyard block is extended and given the pavement which form a tile pattern. The circulation path among the graves are not hardened related to the water catchment and Local Regulation Number 13 of 2003.

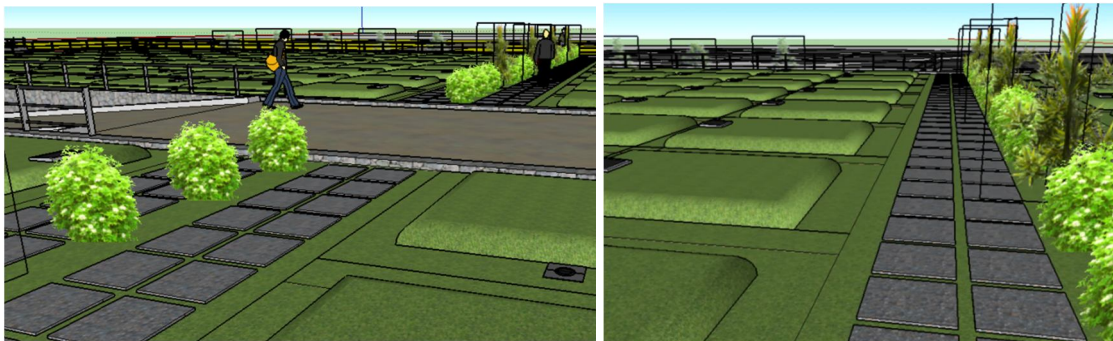


Figure 11. (Left) Entrance of the graveyard block; (Right) The main circulation path which is hardened

### 6.2.4 Landscape Arrangement

Landscape arrangement of grave is using the concept of small plant, which uses a small plant vegetation related to the criteria of design which is resulted. The height of grave is one hand span or  $\pm 20$  cm, height of headstone is quite low, and the use of grass as a whole in the cemetery to create an atmosphere like being in the garden and eliminate the terrifying impression on the cemetery.



Figure 12. Concept of small plant on landscape

### 6.2.5 Circulation Access of Pilgrims and Storage Shed

Stairs are made for the access of pilgrims to the grave. The height of grave elevation is 3.1 meters. Railing is made at the edge of the grave elevation for the sake of pilgrims' security. The storage shed to store the equipments is used to dig graves including portable crane. Storage sheds are available in every main upstairs.



Figure 13. (Left) Access of upstairs; (Right) Shed is located under the main upstairs

## 7. CONCLUSION

Biopore is used as the main concept in the vertical cemetery related to eco-architecture, in which there is mutual relationship between the object in cemetery with the natural environment. The shape of biopore infiltration hole, which is transformed into design, can overcome several problems of design related to the regulation of cemetery in Islam. Related with cemetery, one of the functions of biopore is to decompose organic waste, thus biopore is expected to be able to make the decomposition process on the corpse faster.

The form of vertical cemetery of the Muslim community is similar with other Muslims conventional cemetery. The difference is the dimension of the grave plot. Vertical cemetery has bigger dimension because of the cemetery basement which can accommodate five bodies inside.

The number of bodies which can be buried is five bodies related to the problem of limited land, and also adopts the stack system which are not prohibited in Islam.

## 8. ACKNOWLEDGMENT

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