

The Analysis of Sheet Pile Assets Management in Musi River

Ratih Baniva^{1*}, Maulid M. Iqbal², Heni Fitriani²,

¹Civil Engineering Graduate Program of Sriwijaya University, Palembang, Indonesia

²Civil Engineering Department, Faculty of Engineering, Sriwijaya University, Palembang, Indonesia

*Corresponding author e-mail: baniva_9@yahoo.com

Abstract

Sheet pile, located on the bank of Musi River in Palembang, is the city master plan in the development of Palembang City. The construction of the sheet piles in Musi River was built from 2006 to 2014 but until now there is no further management on the working sheet piles. The aims of this study were to identify the management status of Musi sheet piles and to analyze the damage level that occurred in Musi sheet piles in Palembang. Based on the results of the analysis, it can be obtained that the management status of the sheet pile was the authority of BBWS Sumatera VIII as the constructor and the owner of sheet pile assets, and it is planned that there will be a Musi sheet pile management program in 2019. Sheet piles were in a good condition on the components of pile cap structure, sheet pile, and platform at 16 Ilir, 9-10 Ulu, 11-14 Ulu and sheet pile wall structural components at 11-14 Ulu which have a damage percentage of more than 10%. A Good conditions were also seen in the supporting structure of the fence which has a damage percentage of 0.28% for 9-10 Ulu and 1.45% for 11-14 Ulu. Sheet pile in minor damaged conditions occurred in sheet pile structural components of 10.38% in 11-14 Ulu. Sheet pile components in good condition, minor damaged condition and moderate damaged condition repairs can be done with preventive maintenance or minor repairs.

Keywords

management status, damage levels, Musi sheet pile

Received: 3 June 2019, Accepted: 22 June 2019

<https://doi.org/10.26554/ijems.2019.3.2.60-66>

1. INTRODUCTION

In the construction of the Musi River infrastructure in Palembang, on the left and right cliffs of Musi River, retaining walls were built with a type of sheet pile constructions. Musi sheet pile is a city master plan in the development of Palembang City in order to overcome the riverbank scour. According to Aurdin (2015) the concept of structuring the bank of Musi River was with the arrangement of water front plan in Palembang as one of the attempts to restore the water areas to public property and plan space along the banks of the river which is oriented to water by building cliffs or sheet pile along the banks of the Musi river.

The construction of the sheet piles in Musi River was built from 2006 to 2014 and was conducted in stages started from constructing the sheet pile in Ilir then continued to Ulu. However, until now, there is no further management on the working sheet piles. It is feared that the condition of the damaged buildings can cause the sheet piles break faster than the service life, so that it requires the rehabilitation of the building which means that it costs more.

According to the Government Regulation No. 35 of 1991 concerning the river, one of which is related to the handling of

water. This is confirmed and strengthened again in Law Number 9 of 2015 concerning regional governments that share the authority to manage facilities and infrastructure to the central, province and district or city governments. In order to find the best way to manage sheet pile infrastructure, an agency which is authorized and responsible for managing the sheet pile so that the physical condition of it can function as its service life is needed. This is a challenge for the government in managing sheet pile infrastructure assets so that it can give positive contribution optimally in its development.

The aims of this study were to identify the management status of Musi sheet piles which involved the concerned and adjusted stakeholders based on the government's rules and regulation to the sheet pile management. Then, the next objective of this study was to analyze the damage level that occurred in Musi sheet piles in Palembang by measuring directly to the field so that the value of the existing condition of the sheet pile can be obtained. The limitation of this study was that this study was conducted in 3 locations, 16 Ilir, 9-10 Ulu and 14 Ulu sheet piles by selecting the sheet pile structural component which damage was examined only to the extent of being seen or exposed.

1.1 Sheet Pile

Sheet pile is a river infrastructure that can withstand the pressure of the surrounding soil, prevent landslides and usually consist of sheet pile walls and supports. The construction of sheet pile walls consists of several sheet piles which are installed into the ground, and form a vertical continuous wall formation which is useful for holding back soil or sloping land. Sheet pile consists of prefabricated or pre-cast parts (Sri Respati, 1995).

Sheet pile is a thin, flat, and long vertical wall, it is usually made of steel or concrete material which functions not only to hold the soil but also the water that come into the pit (Das, 2011). The Musi sheet pile wall uses cantilever sheet pile that is combined with platform sheet pile. In planning the sheet pile on Musi River in Palembang, the sheet pile functions as cliff guard, border line between land and river, docks, green open space and road inspection. It is expected that the sheet pile along the banks of the Musi River can withstand lateral loads of the ground and external loads in the form of static or dynamic work in the rear area of the sheet pile (Aurdin, 2015).

The sheet pile building components in the Musi River are more oriented to the dock system where the sheet pile is made not blocking or closing the flow of groundwater from the inside of the sheet pile so as to enable the hydraulic balance of the left and right of the road especially in the rainy season and flood. According to (Usman, 2009) the maintenance of building components requires serious attention in order to obtain maximum results that are expected to make the building more comfortable with good facilities. In the distribution of Musi sheet pile components based on the field of structural components, namely pile, sheet pile, pile cap, beam and platform.

In analyzing the damage level, a physical damage condition of the sheet pile is needed as the criteria for determining the maintenance of sheet pile. According to Circular Letter No. 01/SE/D/2013 Maintenance of River Infrastructure and River Maintenance in attachment II classification of river infrastructure conditions are as follows:

- Good condition, if the damage level is still below 10% (ten percent) of the initial conditions of construction.
- Minor damage condition, if the damage level is 10% (ten percent) to 20% (twenty percent) of the initial conditions of construction.
- Moderately damaged condition, if the level of damage is 20% (twenty one percent) up to 40% (forty percent) of the initial conditions of construction.
- Severe damage condition, if the damage level has exceeded or equals to 40% (fourty percent) of the initial conditions of construction.

According to regulation of Ministry of Public Works and Public Housing number 06/PRT/M/2015 the definition of operation and maintenance is regulating, implementing, monitoring and evaluating activities to ensure the sustainability of functions and benefits of water resources. Infrastructure that has been operating will decrease in condition along with the high intensity and frequency of usage. Changes in environmental conditions or increased decline in infrastructure conditions

are caused by many things. Some common causes (Hudson et al., 1997):

- Limited investment funds for public works produced by infrastructure resulting in quality in accordance with the available budget.
- Lack of management management systems that use the infrastructure.
- There is no preparation of funds for the future.
- The infrastructure manager is not responsive to immediately repair the infrastructure when repairing the damage, so that when repaired the damage must be very severe to require even more costs.
- There is no awareness of the government that requires infrastructure that is made by the government and also given the fulfillment of community rights.
- There is a replacement from the central or regional government for reimbursement of maintenance activities.

In handling the condition of the structure that is damaged, the physical maintenance is needed so that the structure in the building can function in accordance with the purpose of its construction. According to Circular Letter No. 05/SE/D/2016 The guidelines for the implementation of River Infrastructure OP activities and the maintenance of rivers especially for physical maintenance of river buildings, there are three categories of river OP Guidelines and River Infrastructure according to the hierarchy and the nature of their work, namely:

- Preventive maintenance can be in the form of routine maintenance, periodic maintenance and minor repairs.
- Corrective maintenance can be in the form of special maintenance where the activity of repairing building damage is below 70% to 50%.
- Rehabilitative maintenance can be in the form of asset renewal where the activities repair or rebuild the buildings which the performance value is less than 50% or have been destroyed (without exceeding the function or design of the initial performance).

2. EXPERIMENTAL SECTION

2.1 Study Area

The study area were located in Ilir section, sheet pile in front of 16 Ilir Market, and in Ulu section, sheet piles in 9-10 Ulu and 11-14 Ulu which were located in the center of Palembang, South Sumatera. In this case, the construction of sheet pile in Musi River in Palembang was functioned as cliff reinforcement which was one of the ways to overcome the riverbank scour. These sites were chosen by considering the years of building the sheet piles. Here are the different research sites of Musi sheet pile that can be seen in Figure 1.

2.2 Methods

The methods used in this study are as follows :

2.2.1 Questionnaire

This questionnaire method was aimed to determine the management status of sheet pile in Musi River by using primary



Figure 1. Study area

data which was obtained from the questionnaire results through the agencies related to the construction of the sheet pile in Musi River in Palembang. This questionnaires were given to 6 (six) related agencies, such as BBWS Sumatera VIII, Public Works Department of Palembang City, Public Works Department of South Sumatera Province, BAPEDA of Palembang City, Transportation Department of Palembang, Transportation Department of South Sumatera.

The total number of questionnaires distributed in this study was 18 respondents. The distribution of the questionnaire for each agency was given 3 samples. The distribution of questionnaires that have been distributed and returned can be seen in Table 1.

Table 1. The description of the questionnaire on the respondents

No	Description	Frequency	Percentage
1	Distributed questionnaire	18	100%
2	Returned questionnaire	18	100%
3	Failed questionnaire	0	0%
4	Questionnaire used	18	100%

From table 1, the level of the questionnaire that was distributed and returned had a percentage of 100% so that in this study, all returned questionnaires can be processed into data. It used open-ended questionnaires so that the respondents were able to answer the questionnaires as well as provide the reasons behind them.

2.2.2 Field Survey

This survey method was aimed to get the measurements results of the damage that occurred in the components of the sheet pile structure in the field. Therefore, the results of the existing condition of the sheet pile were visually obtained. The measurement of the damage was done by using boat because of the limited location in the river and tidal water that occurred.

The instruments used in surveying the damage of the sheet pile components in the field were: GPS, roll meter, camera, digital caliper, and stationery

2.2.3 Analysis Phases

The analysis used in this study are as follows

The analysis of management status of Musi sheet pile questionnaire : The method used in identifying this questionnaire was descriptive method in which the questionnaire and the interview were reviewed and adjusted to the applicable regulations, then they were described so that the agencies' perception related to the management of Musi sheet pile were obtained.

The analysis of the damage of Musi sheet pile: The method used in analyzing the damage level was survey method which referred to The Guidelines of Implementing River Infrastructure and River Maintenance OP Activities. Furthermore, the steps in analyzing the damage level of the Musi sheet pile are as follows:

- Observing the research sites in 16 Ilir, 9-10 Ulu and 11-14 Ulu sheet pile infrastructures.
- Measuring the existing condition of the damaged sheet pile directly
- Taking note of the kinds of damage on the inspection sheet.
- Measuring the volume of the damage by using this formula:

$$PxLxT \tag{1}$$

Where : P = Damage length; L = Damage width; and T = Damage height. In determining the volume of the damage, the formula used was adjusted to the shape of the damage occurred.

- Measuring the percentage of the damage that obtained by using this formula:

$$\%damage = \frac{damagevolume}{Initialvolume} x 100\% \tag{2}$$

Where : Damage volume = Volume obtained from the results of the measurement of the damage in the field; Initial volume = Volume obtained from the initial dimension of the construction.

- Classifying 4 (four) categories based on the damage percentage, they were good, minor damage, moderate damage, and severe damage conditions. According to the Circular Letter No. 01/SE/D/2013 about the Maintenance of River Infrastructure and River Maintenance in attachment II where the damage percentage became the priority scale for the physical maintenance of the sheet pile components.

3. RESULTS AND DISCUSSION

3.1 The analysis of management status of Musi sheet pile questionnaire

To identify the management status of Musi sheet pile, the questionnaires that consisted of 10 (ten) items related to the construction and the management of Musi sheet pile were distributed to 6 agencies with total number of the respondents

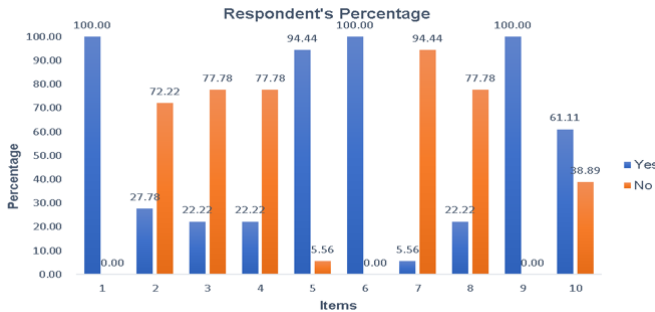


Figure 2. Respondents' Percentage

were 18 people. Therefore, the results obtained from the respondents can be seen in Table 2. In addition, from table 2,

Table 2. The Results of the Respondents' Answers

Items	The Results of the Respondents' Answers	
	Yes	No
1	18	0
2	5	13
3	4	14
4	4	14
5	17	1
6	18	0
7	1	17
8	4	14
9	18	0
10	11	7

if the results of the respondent's answer to the questions were included in percentage category of respondents, then it can be seen in Figure 2. In figure 2, the total number of the respondents who answered yes for question one, six, and nine were 100%, meanwhile, the total number of the respondents who answered yes for question three, four, and eight were 22,22%. For the remaining questions, the percentage produced varies, for respondents who answered yes for question two were 27,78%, for question ten were 61,11%, for question five were 94,44%, and 5,56% for question seven.

The results of this percentage can be described from the respondents' response. Therefore, the information obtained were as follows:

- Musi sheet pile in Palembang is a city master plan in accordance with the Spatial Plans year 2012-2032.
- Human Resource Management Department South Sumatera Province, Public Works and Spatial Plans Department, BAPPEDA of Palembang City, Transportation Department of Palembang and Transportation Department of South Sumatera have roles as the users, meanwhile BBWS Sumatera VIII as the constructor.
- Musi sheet pile in Palembang is owned by BBWS Su-

matara VIII.

- Musi sheet pile inventory has been done by BBWS Sumatera VIII related to the assets ownership and the Public Works and Spatial Plans Service only because the location is in Palembang.
- Musi sheet pile in Palembang functions as the cliff reinforcement.
- The management / maintenance needs to be done so that it remains functioning optimally.
- The maintenance has not been carried out until now because the operation and maintenance of Musi sheet pile is not budgeted in the Activity Budget Plan, but it will be planned for a sheet pile maintenance program in 2019 by BBWS Sumatera VIII.
- No coordination has been held regarding the management / maintenance of the Musi sheet pile in Palembang. The coordination between agencies is only carried out limited to planning and development.
- Delegation of management of Musi sheet pile can be done in deconcentration to the provincial or city governments concerned.
- BBWS Sumatera VIII is willing to be given the responsibility of managing the Musi sheet pile in Palembang because it is in accordance with its authority where the assets are owned by the central government

In referring to the regulations, the provisions on management of Musi sheet pile have been clearly stated in Minister of Public Works Regulation No. 04/PRT/M/2015 and Law No. 23 of 2014 is the authority of the central government or BBWS Sumatera VIII, but if it is associated with Law No. 26 of 2007 concerning spatial planning is made possible by the city government authority. Overall, the management of Musi sheet pile in Palembang is the authority of BBWS Sumatra VIII where in the concept of the strategic plan for the implementation of the 2010-2025 OP SDA that all SDA assets must be OP in good condition, minor damaged, and moderately damaged or already completed. This is expected to be able to maintain the condition and function of sheet pile according to the service age. So that it is expected to be able to carry out the operation and maintenance of sheet pile according to the plan.

3.2 The analysis of the damage of Musi sheet pile

The measurement of damage conditions in each component of sheet pile is obtained from survey information data directly in the field by tracing these sheet pile components which will be recorded on a form that is given an inspection record of the component by marking existing / real damage in the field accompanied by documentation of damaged parts and description the damage. From the calculation of the percentage of damage that has been done, it can be classified the conditions in each component of the sheet pile structure by referring to SE 01/SE/D/2013 by clarifying the condition of the sheet pile into four conditions including: good, minor damage, moderately damaged and severe damage conditions. The following are the results of recapitulation of damage calculations that

have been classified in 3 sample research sites.

3.2.1 16 Ilir Sheet Pile

16 Ilir sheet pile which is right in front of 16 market was built in 2006 with a length of 93 meters. After a field damage survey was carried out on each component of the structure and supporting structure of the sheet pile, the results of the sheet pile condition were obtained as follows.

From Table 3, it can be seen that the sheet pile structure of the platform component has the largest percentage of 2.389% and the component structure of the pile cap has the smallest amount of 0.004%. This percentage value was still in the sheet pile category still in good condition because the percentage produced in each component was less than 10%. While in Table 4, for supporting structural components on the fence, the condition was moderately damaged because it has a percentage of 21.739 % or more than 20%.

3.2.2 9-10 Ulu Sheet Pile

9-10 Ulu sheet pile, located in Ulu part between the Ampera bridge the temple court, was built in 2007 with the length of 174 meters. This sheet pile has a type of sheet pile with a cross section of the sheet pile in the front. After conducting a damage survey in the field on each component of the structure and supporting structure on the sheet pile, the results of the sheet pile condition were obtained as follows.

From Table 5, the highest percentage of structural damage was found in the components of the platform structure of 2.892% and the lowest percentage value was in the pile component of 0.003%. Whereas the value of the percentage of damage to the supporting structure of the fence has a percentage of 1.452%. So that from these results the structural components and structural components of the plaster support were in good condition.

3.2.3 11-14 Ulu Sheet Pile

11-14 Ulu sheet pile was an advanced plaster built in 2013 and has a length of 83 meters. After a field damage survey was carried out on each component of the structure and supporting structure of the sheet pile, the results of the sheet pile condition were obtained as follows:

From Table 6, it can be seen for the supporting structure components on the fence having a damage percentage of 4.821% and for the components of the pile structure, the pile cap and platform have a percentage of less than 10% or in good condition. In contrast, in Table 7 the structure of the sheet pile wall component was 10.387% or minor damaged.

3.3 Discussion

Damage to components in sheet pile in the Musi river is caused by several factors including the high tide of river water, garbage piles, ship or boat backrest and a lack of attention in managing sheet pile on the Musi river. This causes damage to the sheet pile components so that in the handling effort it is necessary to maintain each component of the sheet to support the optimal

sheet pile function. Maintenance can be carried out by the asset management body in accordance with the activity budget plan by considering the damage to the sheet pile component that occurs so that the consistency of the sheet pile function.

4. CONCLUSIONS

The conclusions of this study are:

- From the results of the sheet pile management status identification it can be concluded that the management of Musi sheet pile in Palembang was the authority of BBWS Sumatra VIII as the constructor and owner of the sheet pile assets and will be planned for the Musi sheet pile maintenance program in 2019.
- Sheet pile in good condition occurred in components of the structure of pile cap, pile, platform, at 16 Ilir, 9-10 Ulu, 11-14 Ulu and sheet pile wall structural components at 11-14 Ulu which have a damage percentage of more than 10%
- Good conditions were also seen in the supporting structure of the fence which has a damage percentage of 0.28% for 9-10 Ulu sheet pile and 1.45% for 14 Ulu sheet pile.
- Sheet pile in minor damaged conditions occurred in sheet pile structural components of 10.38% in 11-14 Ulu.
- Sheet pile components in good condition, minor damaged condition and moderate damaged condition repairs can be done with preventive maintenance or minor repairs.

5. ACKNOWLEDGEMENT

Acknowledgements for government agencies namely Balai Besar Wilayah Sungai Sumatera VIII

REFERENCES

- Aurdin, Y. (2015). Sheet Pile Design to Overcome the Scour of Musi River 600 Meters Long of Seberang Ulu (Kampung Kapiten-Musi II Bridge) in Palembang. *Teknika Journal*, 2(2)
- Das, B. (2011). *Principles of foundation engineering (4th ed.)*. PWS Publishing Company.
- Hudson, W., R. Haas, and W. Uddin (1997). *Infrastructure Management*. McGraw-Hill, New York
- LocalGovernment (1991). Government Regulations Number 35 Year 1991 Concerning the River
- LocalGovernment (2007). Constitution Number 26 Year 2007
- LocalGovernment (2014). Constitution Number 23 Year 2014
- LocalGovernment (2015). Constitution Number 9 Year 2015
- PUPR (2013a). Public Works Ministry of the Republic of Indonesia, Attachment II, Maintenance of River Infrastructure and River Maintenance, Circular Letter of Public Works Ministry Number 01/SE/D/2013. Technical report, Directorate General of Water Resources, Jakarta
- PUPR (2013b). Public Works Ministry of the Republic of Indonesia, Guidelines of Implementing the Operational Activity and Maintaining River Infrastructure and River Main-

Table 3. Percentage of sheet pile components in good condition

Field	Component	Unit	Initial Volume	Damage Volume	Damage Percentage
Structure	Pile Cap	m ³	325.50	0.01	0.004
	Pile	m ³	1131.53	0.17	0.015
	Platform	m ³	404.55	9.67	2.389
	Sheet Pile wall	m ³	55.8	0.67	1.207

Table 4. The percentage of sheet pile components in moderate condition

Field	Component	Unit	Initial Volume	Damage Volume	Damage Percentage
Supporting Structure	Fence	m ³	184	40	21.739

Table 5. The percentage of good sheet pile component

Field	Component	Unit	Initial Volume	Damage Volume	Damage Percentage
Structure	Pile Cap	m ³	366.14	0.02	0.004
	Pile	m ³	1534.52	0.05	0.003
	Platform	m ³	1534.52	0.05	2.892
	Sheet Pile wall	m ³	174.35	0.52	0.298
Supporting Structure	Fence	m ³	4.97	0.07	1.452

Table 6. Percentage of sheet pile components in good condition

Field	Component	Unit	Initial Volume	Damage Volume	Damage percentage
Structure	Pile Cap	m ³	216.72	1.28	0.591
	Pile	m ³	664.68	0.19	0.028
	Platform	m ³	103.2	0.98	0.946
Supporting Structure	Fence	m ³	3.13	0.15	4.821

Table 7. The percentage of the sheet pile component in minor condition

Field	Component	Unit	Initial Volume	Damage Volume	Damage Percentage
Structure	Sheet Pile Wall	m ³	68.8	7.146	10.387

- tainance, Circular Letter of Public Works Ministry Number 05/SE/D/2016. Technical report, Directorate General of Water Resources, Jakarta
- PUPR (2015a). Regulation of Ministry of Public Works and Public Housing of the Republic of Indonesia, Number 04/PRT/M/2015 Concerning Criteria and River Basin Determination.
- PUPR (2015b). Regulation of Ministry of Public Works and Public Housing of the Republic of Indonesia, Number 06/PRT/M/2015 Concerning Exploitation and Maintenance of Water Resources and Irrigation Buildings.
- Sri Respati, N. (1995). *Foundation*. PT. Penerbit Pusat Pengembangan Pendidikan politeknik, Bandung
- Usman, K. (2009). *Management review of building maintenance in Lampung University*. University of Lampung