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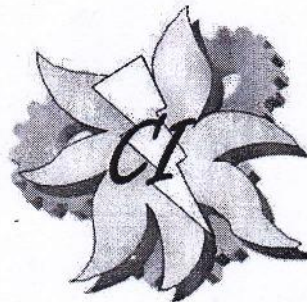
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# Comparison Study of Stabilization Work using Sheet Piles made of Reinforced Concrete-Steel-Vinyl

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**Abstract:** This paper presents a comparison study on the use of sheet pile as protection in normalization work of the river embankment against scouring. In this study briefly described the use of sheet pile as soil reinforcement of the embankment of the river against landslide. Further the use of sheet pile for the river embankment stabilization work is described. Then, the comparison study of the use of sheet piles that has been used at several locations in Batang Anai and Batang Manggor is elaborated. Both of these sites have the same of geotechnical characteristics and the geography, so the comparative study can be carried out. The sheet piles are made of concrete, steel and vinyl. At the end of the study presented a comparison of these three types of sheet pile in terms of cost of materials and workability on sites.

**Keywords:** River, Sheet pile, Construction Cost

## 1. Introduction

West Sumatra Province in Indonesia with a total area of about 42300 km<sup>2</sup>, is geographically located in the central-western side of the Sumatra Island (Figure 1). The West Sumatra province has more than 600 large and small rivers. In the middle side of West Sumatra province there are hills stretches from the north to the south as part of the Bukit Barisan Range. The hills became the starting point at the start of the rivers of West Sumatra. So in general the river in West Sumatra can be divided into two different types of river flows that are toward the western and the eastern directions. The geographical condition of those areas causes the flow pattern in that two types of flows are very diff

The character of river flow in the eastern part of Sumatra has a relatively slow currents and calm. This is because the slope is un-steep topography. In contrast to the western side, the distance between the rivers springs with the shore are relatively short with high topographical differences. So that the flow of water in the western island of Sumatra fast and have a fairly high scour potential. This nature results in the many landslide of riverbank that generally occurs during the rainy season. So there is several the stabilization works on many river sites in West Sumatra.

The use of sheet piles for slopes on River basin have been carried out in many countries. Stabilization of the water bodies can be done with sheet pile applications are made of various materials. Materials that can be

used as a sheet pile are steel, reinforced concrete, vinyl, fiber-reinforced polymer (FRP), and woods.

Every sheet pile material has advantages and disadvantages. Sheet pile of wood, for example, must be treated to protect against rodents. Reinforced concrete material is relatively rigid than other materials. Steel sheet pile walls can be planted as a cantilever with a depth of up to 8m without anchor. Steel sheet pile is also believed more economical for the excavation work in (Stuart, [4]). While the vinyl sheet pile is relatively driven shorter than steel, which is just up to half of it. While the FRP can be used for corrosive areas where steel and reinforced concrete material less suitable applied.

Sheet pile can be driven at some distance from the river slow (Figure 2) or in direct contact with slow the river (Figure 3). Those differences are strongly influenced by the behavior of the soil condition of on-site and hydraulic behavior of water in the river basin. For water bodies with relatively slow without scouring potential, then the installation of the first type is more desirable. In contrast to the flow tends to scour the river banks, the sheet pile with a second type installation is technically more helpful. In addition besides the construction method, the sheet pile application need also environment-related considerations function and good looks of the river to the presence of sheet pile structures in the area. For example of the environmental consideration is the installation of sheet pile by

presenting vegetation to make it look more natural and friendly with the surrounding (Figure 4).



Figure 1 The Map of West Sumatra Province

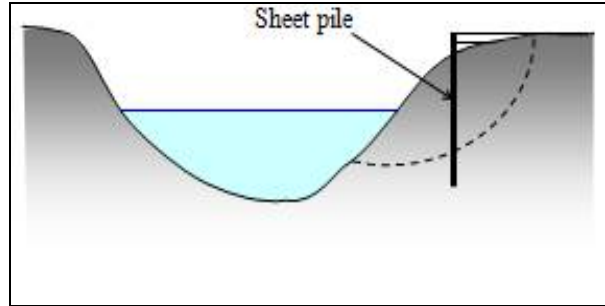


Figure 2 Sheet pile with a distance to the flow

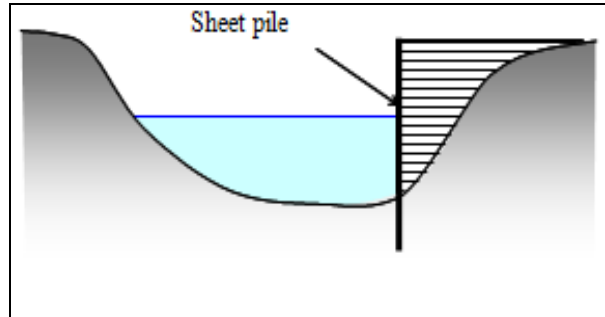


Figure 3 Sheet pile for scouring protection

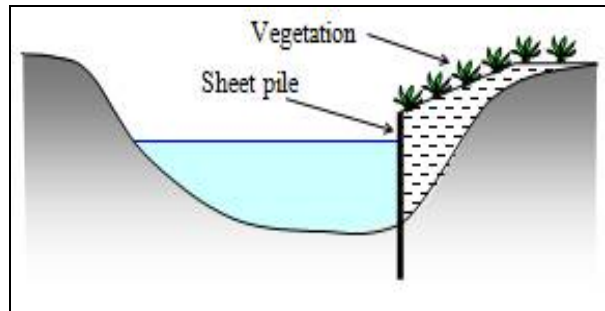


Figure 4 Sheet pile with vegetation

For locations that have good soil properties, the structure of cantilever sheet pile is usually enough (Figure 5). But for the site with disadvantages properties of the soil condition, it is necessary to use the anchor to provide better stability (Figure 6). In many locations there is even necessary to construct double layered of sheet piles (Figure 7).

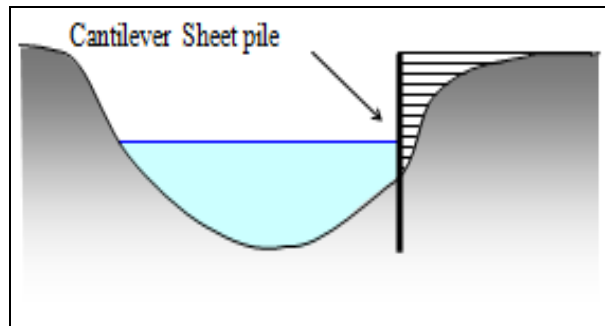


Figure 5 Cantilever sheet pile

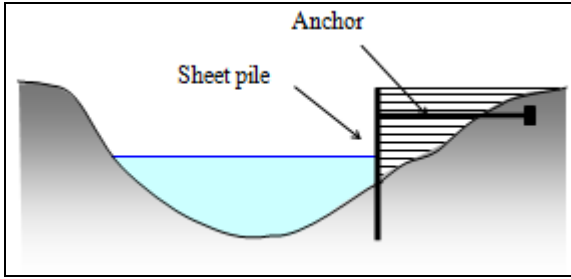


Figure 6 Anchored sheet pile

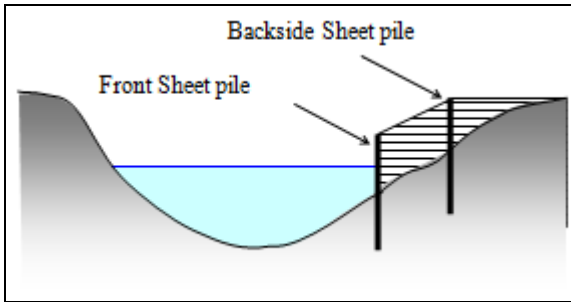


Figure 7 Double sheet pile

The selection of sheet pile application at a location, including the material selection, the construction method, the environmental considerations will consequently result the difference in the work budget. The difference in choosing material with the various shapes, properties and their advantages then will result the difference in cost to complete the work. The cost project will also take account of all technical and non-technical considerations. Then all of them will effect in the making decisions of riverbank stabilization work using sheet pile.

In this paper will be described the sheet pile project at a nearby location in the district of Padang Pariaman, West Sumatra Province. The projects generally have difference in planning but have the same purpose with similar ground characteristic. Budget components of sheet pile application are based on the installed sheet piles on site.

**2. Sheet piles project in Pariaman**

The locations where the applications sheet pile have been installed are project sites for river bank stabilization in Batang Manggor and Batang Anai. Both locations are geographically close to each other and on the same administration/authorization of the Padang Pariaman district, West Sumatra. The both sites are also located on the river near the shoreline that are relatively flat.

Since the project locations are within the same administrative region, it has an advantage that the decision maker to determine the choice of materials is the same. The same persons also are having

authorization to make the financial assessment. The organization in charge of this work is the Department of Water Resources Development (PSDA) of West Sumatra Province.

With a nearby location, the geotechnical soil data available at the site is relatively the same. In Batang Anai, soil deposit on the project site is dominated by sandy soil. Similarly to the ground site at the location on the river stabilization work on Batang Manggor is also dominated by sandy soil. Typical results of the soil investigation in the term of boring logs and standard penetration test (NSPT) at the project locations in Padang Pariaman are shown in Figure 8. The maximum value of standard penetration blows is about 30.

Based on the data of geotechnical, hydrological and other considerations, then river bank stabilization project plans using sheet pile are initiated. The main difference between the project locations is the use of sheet pile with dissimilar materials. In addition, the depth and method of construction also are not the same for each location. Sheet piles used for Batang Anai project are made of reinforced concrete which included double sheet piles. The sheet piles at the adjacent to the river stream have a depth of 12m combined to 7m sheet pile behind (Figure 9).

The project work on the Batang Manggor is decided to use sheet pile materials that are made of steel and vinyl. The steel sheet piles are driven into a depth of 8 m (Figure 10), meanwhile vinyl sheet piles are driven up to 6 m (Figure 11)

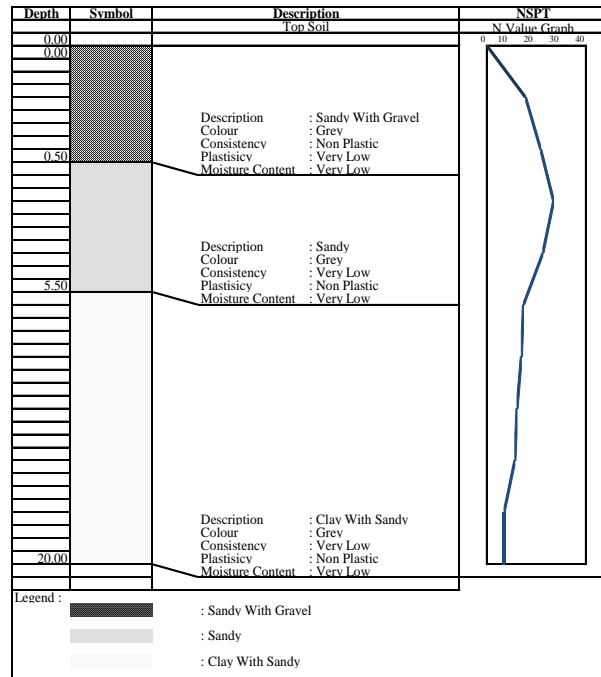


Figure 8 Typical boring log

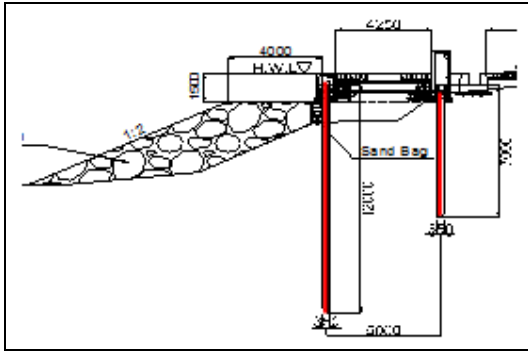


Figure 9 Batang Anai (Concrete) Construction

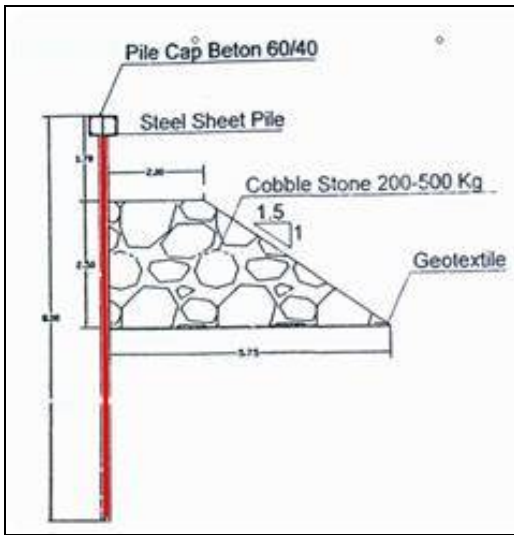


Figure 10 Batang Manggor (Steel) Construction

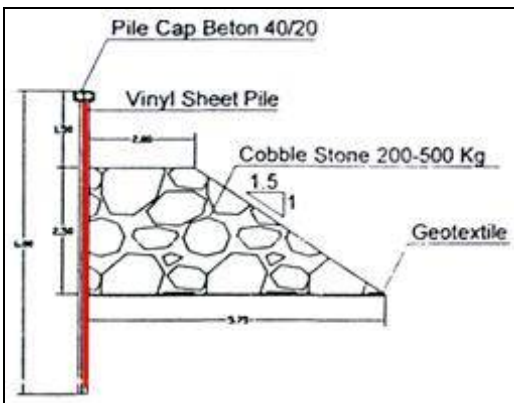


Figure 11 Batang Manggor (Vinyl) Construction

### 3. Comparison of sheet pile

Based on field observations at the construction time, then the installation work of reinforced concrete sheet piles experienced more frequently problems the others. This problem is generally caused by the large cross section of the concrete sheet pile tip in contact with the ground when it is driven. Compared to concrete sheet piles, the steel and vinyl sheet piles are relatively easy

during installation since the cross section (the thickness) of sheet piles is relatively smaller. The vibrator machine to drive the concrete sheet piles also has a larger capacity than the others. In addition, vinyl sheet pile can be cut neatly and easily using simple equipment such as chainsaws (Figure 12). The concrete and steel sheet piles require more difficult cutting efforts.



Figure 12 Cutting off vinyl and concrete sheet piles

In fact that the project locations are in the area that has a high level of corrosion, the vinyl material more reliable for this reason. Steel sheet piles at several locations have started having corrosion process (Figure 13), so they need to be covered by protective paint.



Figure 13 Corrosion on steel sheet piles

Differences in the use of sheet pile on the river stabilization projects are caused by the consideration of technical and non-technical. The differences then result of difference in the execution of the work including the cost of each material used. By considering the same Decision Makers as well as geographical and geotechnical similarities, then the budget comparisons using the same unit price can be examined.

Table 1 Material and installation costs (US\$ 1=Rp. 11,500)

No.	Material type	Cost (Rp)		Total cost (Rp)
		Material	Installation	
1	Concrete	946,931	234,245	1,181,176
2	Steel	3,064,913	266,250	3,331,163
3	Vinyl	1,266,499	104,559	1,371,058

Table 1 shows the comparison of the cost of materials procurement and installation of the sheet pile applications in riverbanks stabilization projects with different materials. The cost listed above is the cost per meter length of material and installation costs for the sheet pile. Steel sheet pile are relatively more expensive both procurement and installation compared to others. Although the price of the concrete sheet piles is relatively cheaper *but* the installation cost is more expensive than the vinyl.

**Table 2** Sheet pile budget after installation (US\$ 1=Rp. 11,500)

No.	Sheet pile material	On site unit price per meter (Rp)
1	Concrete ( per 10m)	12,173,320
2	Steel (per 8m)	39,973,956
3	Vinyl (per 6m )	8,226,347

Table 2 shows the cost comparison that installed sheet pile on project sites. Due to differences in planning, then the depth of each project, the length of installed sheet pile is also different. However, in general it can be seen that the vinyl sheet pile is the cheapest. The steel sheet pile is relatively much more expensive compared to the other two types of sheet pile.

#### 4. Conclusions

Riverbank stabilization project can be completed by using sheet piles as a construction option. However, the application needs the decision to choose the right type of sheet pile that is available. The project decision maker requires considering the technical and non-technical matters related to geotechnical and geographical data as well as consideration on sites. In the installation process, the vinyl sheet piles are

relatively easier and cheaper compared to concrete and steel sheet piles.

The costs needed for the implementation of sheet pile are mainly affected by the differences in the material selection. This selection of material will in turn results the budget incurred as a consequence of the differences in the cost of materials, installation and human resources costs as well as other components of the cost of the work. Based on the comparison of costs in this study, it can be concluded that the budget of river banks stabilization project with steel sheet piles is much more expensive compared to concrete and vinyl sheet piles. Moreover, steel materials require post-construction maintenance especially to protect from the possibility of corrosion.

#### Acknowledgment

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