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Risk Analysis Analysis Of Cantilever Wall And Sheet Pile As River Cliff Reinforcement Methods

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ABSTRACT: *The road infrastructure network in the Balangan Regency is almost mostly located on the side of the hillside and river cliffs which is risky to erosion and landslide of the road on cliffs. Almost every year there are landslides occures which result in the cut off of road access, especially the roads that are located on the side of the river cliff. The implementation of river cliff reinforcement in Balangan is currently limited to counterfort retaining wall construction and concrete sheet pile. In fact, with the development of the construction technology there are several alternative river cliff reinforcement constructions that can be applied in Balangan Regency. The purpose of this study is to analyze the risk of two river cliff reinforcement constructions methods. The selected implementation construction is sheet pile construction which is the existing construction in Balangan Regency and cantilever wall construction which is proposed as an alternative to river cliff reinforcement construction. The risk analysis method used is the risk analysis of construction projects based on probability impact matrix. As the results of the risk analysis obtained sheet construction has an average risk level of 4.25. The cantilever wall construction has a lower risk level of 3.72. In general, both construction of cliff reinforcement do not have a high level of risk. However, sheet pile construction has more medium level of risk compared to cantiever wall construction. Therefore, based on the risk analysis results, it is recommended to use cantilever wall construction as river cliff reinforcement method that can be applied in Balangan Regency.*
KEYWORDS: *Balangan Regency, River Cliff Reinforcement, Sheet Pile, Cantilever Wall, Risk Level Analysis.*

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I. INTRODUCTION

Nowadays, in Balangan regency some rivers have been damaged, starting from minor damage up to the river channel such as erosion and degradation which are longer will continue into major damage that can cause disasters such as landslide on river cliffs. Damage that occurs on river cliffs will destruct the building facilities around the river and endanger the safety of communities alongside the river cliff.

The road infrastructure network in the Balangan Regency is almost mostly located on the side of the hillside and river cliffs which is risky to erosion and landslide of the road body cliffs. Almost every year there are landslides which result in damage to even almost the cut off of road access on some roads, especially roads located on the side of this river cliff.

Studies conducted from several studies show that there are several constructions methods commonly used for construction of river cliff reinforcement, including: concrete cantilever retaining wall, masonry gravity retaining wall, concrete corrugated sheet pile, steel sheet pile and gabion wall. Amran et al (2017) planned the Way Batanghari River retaining wall with such a gravity type retaining wall revetment method, his research obtained a safe dimension for the river cliff reinforcement with a width of 0.5 m, a base width of 3.6 m and a height of 6 m. Irianto et al. (2014) examined pile driving of Corrugated Sheet Pile Concrete on the Wonokromo River Improvement Surabaya project, in the implementation of this project W350B corrugated sheet pile concrete was used with a length of 10 meters and using K-700 concrete quality.

With several cliff reinforcement methods that can be used, it is necessary to take carefully consideration to determine the most suitable method for cliff reinforcement contruction to built in the location.

The construction of river cliff reinforcement in Balangan Regency is currently limited to the construction of sheet pile and gabion retaining wall, however there are other construction alternatives that can be applied to river cliff reinforcement, one of them is cantilever wall, therefore the construction of sheet pile and cantilever wall are chosen to be applied in the cliff of the Balangan River Kupang Village. This location has characteristics that are quite different from the condition of the balangan river cliffs that have been conducted in Balangan Regency, one of them is the condition of the location with access roads that are not too wide and crowded population, this condition represents several river cliff conditions that are currently experiencing slides and the others are about to be conducted, for this reason an alternative choice of effective cliff construction is needed in terms of the risk of carrying out the work in accordance with the conditions of the location in Balangan Regency.

II. METHODS

In this study will be planned alternative building of river cliff protection or reinforcement that is effective to be applied especially for the research location and then analyze the costs, implementation time and risks and also their impact such construction method apllied. The construction alternatives include:
1) River cliff reinforcement using cantilever
2) Reinforcement of river cliffs using Sheet Pile Concrete (Corrugated Concrete Sheet Pile)

The research location is located on the Cliff of Balangan River which experienced landslides in Kupang Village, Lampihong District, Balangan Regency. The length of the conduncting area is 90 m. Primary data collection is done by distributing questionnaires as well interview about aspects of criteria assessed by technical staff in the Public Works Department of Balangan Regency from the field of Water Resources and Bina Marga, planner and supervisor consultants and contractors totaling 30 people.

Risk variables consist of material and equipment risks, worker risks, implementation risks, design and technology risks and management risks. These risk criteria are then further divided into sub-criteria and assessed on a Likert scale of 1 to 5, where Very Rarely (VR) = 1, Rarely (R) = 2, Occasioanlly (O) = 3, Very Frequently (VF) = 4, Always (A) = 5; while to measure the impact is Very Small (VS) = 1, Small (S) = 2, Medium (M) = 3, Large (L) = 4, Very Large (VL) = 5 (PMI, 2008). Assessment of the impact of risk on costs also uses a scale of 1 to 5, where the risk of additional costs is set to a maximum of 10% which is then divided into 5 class intervals. The impact of risk on time, using the limitations in the project, that the maximum delay is 50 days, so the maximum impact about the time is 50 days and then divided into 5 class intervals.

III. DATA ANALYSIS AND DISCUSSION

1. Risk Level Analysis

Based on the results of the value of risk probability, the impact of risk to costs and the impact of risk to time, the risk level of the cantilever and sheet pile construction methods can be analyzed for the development of river cliff reinforcement construction as follows

Tabel I: Analysis of the Level of Risk to Costs.

No.	Variable Indicator	CANTILEVER WALL METHOD			SHEET PILE METHOD		
		Proba bility	Impact to cost	P x I cost	Proba bility	Impact to cost	P x I cost
A.	Material and Equipment Risk						
X1	Inadequate availability of the proper heavy equipments	1,00	2,00	2,00	2,00	2,00	4,00
X2	Damage of parts of machine and project equipments	2,00	2,00	4,00	2,00	2,00	4,00
X3	Unproper equipments to working condition	2,00	1,00	2,00	2,00	1,00	2,00
X4	The difficulty of availability of transportation material to site	2,00	2,00	4,00	3,00	3,00	9,00
X5	Delay in delivery of material from suppliers	2,00	2,00	4,00	3,00	3,00	9,00
X6	Inaccurate quantity and type of procurement of materials	2,00	2,00	4,00	2,00	2,00	4,00
X7	Lack of storage space for materials	2,00	2,00	4,00	2,00	2,00	4,00
X8	Excess use of material (waste material)	3,00	2,00	6,00	3,00	2,00	6,00
X9	A significant increase of material prices	2,00	2,00	4,00	2,00	2,00	4,00
	Average			3,78			5,11
B.	Worker Risk						
X10	Lack of availability of skilled	2,00	2,00	4,00	3,00	2,00	6,00

	worker						
X11	Lack of availability of professional heavy equipment operators	2,00	2,00	4,00	2,00	2,00	4,00
X12	Low worker productivity	2,00	2,00	4,00	2,00	2,00	4,00
X13	Occurrence of work accident	2,00	2,00	4,00	2,00	2,00	4,00
	Average			4,00			4,50
C.	Construction Implementation Risk						
X14	The occurrence of congestion around the project location	2,00	2,00	4,00	2,00	2,00	4,00
X15	Difficult site conditions to implementation	2,00	2,00	4,00	2,00	2,00	4,00
X14	The occurrence of congestion around the project location	2,00	2,00	4,00	2,00	2,00	4,00
X15	Difficult site conditions to implementation	2,00	2,00	4,00	2,00	2,00	4,00
X16	Land conditions that might be unstable and risk of landslides	2,00	2,00	4,00	1,00	2,00	2,00
X17	Difficulties in carrying out work	2,00	2,00	4,00	2,00	2,00	4,00
X18	Failed job because of troublesome	2,00	2,00	4,00	2,00	2,00	4,00
X19	Overflow of groundwater and rising river water level	3,00	2,00	6,00	3,00	2,00	6,00
X20	Error of survey and investigation of site conditions	1,00	2,00	2,00	2,00	1,00	2,00
X21	Uneven compaction at casting	2,00	2,00	4,00	1,00	2,00	2,00
X22	Changing of working schedule	2,00	2,00	4,00	3,00	2,00	6,00
X23	Damage of the other infrastructures around the project	1,00	2,00	2,00	2,00	3,00	6,00
X24	Misadjustment and improper on assembly of iron	2,00	2,00	4,00	1,00	2,00	2,00
X25	Inappropriate of concrete quality	2,00	2,00	4,00	1,00	2,00	2,00
	Average			3,83			3,67
D.	Design And Technology Risk						
X26	The Change of design due to differences conditions on site	2,00	2,00	4,00	2,00	2,00	4,00
X27	Implement of the wrong implementation method	2,00	2,00	4,00	3,00	2,00	6,00
X28	Incomplete and not detailed design	2,00	1,00	2,00	2,00	1,00	2,00
X29	Design errors due to the complexity of work items	2,00	2,00	4,00	2,00	2,00	4,00
X30	Difficulty in using the new technology	2,00	2,00	4,00	2,00	2,00	4,00
X31	Technical specification non-conformance	2,00	2,00	4,00	2,00	2,00	4,00
X32	Eror in Strcuture Calculation	1,00	2,00	2,00	1,00	2,00	2,00
	Average			3,43			3,71
E.	Management Risk						
X33	Lack of experience of Project Manager	2,00	1,00	2,00	3,00	1,00	3,00
X34	Lack of control and coordination among teams	2,00	2,00	4,00	2,00	2,00	4,00
X35	Inaccuracy on contruction budgeting	2,00	2,00	4,00	2,00	2,00	4,00
X36	Inaccuracy of estimating the working implementation	2,00	1,00	2,00	3,00	1,00	3,00
	Average			3,00			3,50
	TOTAL			132,0			148,0
	AVERAGE			3,67			4,11

Based on the results of the analysis of the level of cost risk, obtained the value for the retaining wall construction method of 3.67 and the value for the sheet pile construction method of 4.11.

Tabel II: Analysis of the level of risk to the time

No.	Variable Indicator	CANTILEVER WALL METHOD			SHEET PILE METHOD		
		Proba bility	Impact to time	P x I time	Proba bility	Impact to time	P x I time
A	Material and Equipment Risk			3,78			5,33
B.	Worker Risk			4,00			4,50
C.	Constuction Implementation Risk			4,08			4,17
D.	Design and Technology Risk			3,57			3,86

E.	Management Risk			3,00			3,75
	AVERAGE			3,78			4,39

Based on the results of the time risk level analysis, the risk level of cantilever construction method was 3.78 and the sheet pile construction method was 4.39.

After analyzing the level of risk, the next step is to classify the level of risk using a probability and impact matrix by Williams, T.M (1993).

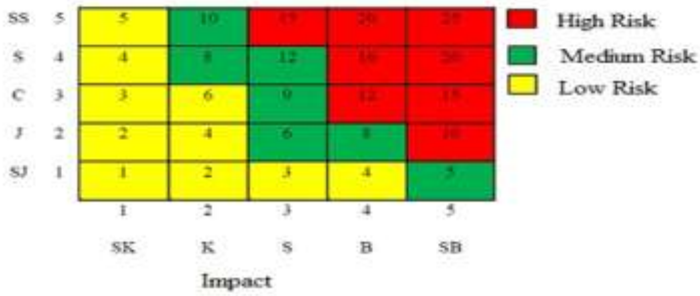

Figure I Probability Matrix-Impact (William, 1993)

If such risks are analyzed by the matrix, sheet pile has more risks compared to cantilever wall, including:

A. Material and Equipment Risks

1. Difficulties in material availability and transportation to the site (X4), with the medium risk to costs and time
2. Delay in the delivery of material from the supplier (X5), with the medium risk to costs and time
3. Damage of parts of machine and project equipments (X2), with the medium risk to time.

B. Constuction Implementation Risk

1. Damage of the other infrastructures around the project (X23), with the medium risk to costs.
2. Difficult site conditions to implementation (X15), with the medium risk to time,
3. Overflow of groundwater and rising river water level (X19), with the medium risk to time,
4. Changing of working schedule(X22), with the medium risk to time.

And for Cantilever has medium qualification risk for variables:

A. Material and Equipment Risks

1. Damage of parts of machine and project equipments (X2), with the medium risk to time.

B. Constuction Implementation Risk

1. Overflow of groundwater and rising river water level (X19), with the medium risk to time.

Contruction Implementation Method

2 Construction Comparison and Selection

Based on the results of the analysis that has been carried out, the level of risk to cost and time obtained, for cantilever and sheet pile construction as in Table III.

Tabel III Risk Analysis Types of Construction

No.	Types of Construction	Cost Risk	Time Risk	Average
1.	Cantilever	3,67	3,78	3,72
2.	Sheet Pile	4,11	4,39	4,25

From the table, cantilever wall has a lower risk level than sheet pile, therefore cantilever will be chosen as the first alternative. In general, sheet pile construction requires a little number of workers compared to cantilever walls, because sheet pile is a precast material, when the materials are on site can be directly fixed with the tools and just a litlle number of workers, while the retaining wall has a lot of work to do on site such as assembling the reinforced concrete and cast reinforcement directly in a place with ready mix, which this job requires more workers and a longer working schedule. However, considering that sheet pile material must be ordered outside Kalimantan and often must be special orders, if there are some delays and problems in production and delivery, it will cause risks that might have an impact on cost and time, in addition there are other risks in sheet pile whose value is higher than cantilever wall.

IV. CONCLUSION

Based on the results of a comparative analysis of the construction of river cliff reinforcement between cantilever and sheet pile, it can be concluded as follows:

1. Evaluation of the selection of river cliff reinforcement construction that has been and will be applied in Balangan Regency is as follows:
   a. Cantilever wall, based on the results of risk analysis, has a risk level of implementation 3.72
   b. Sheet Pile, based on the results of the risk analysis, has a risk level of implementation of 4.25
2. The most effective method of river bank reinforcement construction to be applied in accordance with the conditions in Balangan Regency was chosen by evaluating the risk level criteria. Based on the results of the analysis, cantilever is better than sheet file because it has a lower risk level value than sheet pile and has a lower risk level with a medium classification than sheet pile construction, therefore the retaining wall is chosen as the first alternative.
3. In case of sheet pile construction chosen by the project owner at a location, the work executor should pay attention to the risks that might occur, especially risks with medium classification such as: difficulties in material availability and transportation to the site, delay in the delivery of material from the supplier, damage of parts of machine and the project equipments, difficult site conditions to implementation, Overflow of groundwater and rising river water level and changing in working schedule.
4. In case of offering, the executor should be more careful in considering the risks that that might occur, due to the risk can cause additional costs and time which results in reduced profits to earn.

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