

Analysis of The Cost and Time Comparison of Diversion Methods and Dewatering of Box Culvert Work

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Abstract

Low geographical conditions and flowed by many rivers and the reduction of retention ponds in Jakarta, then built a reservoir. However, during the implementation period, it was delayed by 9.74%. One of the things that can be done to overcome delays is to choose a method of implementation. The method is diversion and dewatering. The results of the analysis are expected to produce a large comparison of the costs and time of each method. From the analysis results, the cost of implementing the method of soil and rock diversion in the box culvert work is Rp. 363,935,953, while the sandbag diversion method is Rp. 332,805,831. For box culvert work using open pumping dewatering method, the required cost is Rp. 394,637,510. From these data, it was concluded that the difference in the cost of diversion sandbag and rock soil was Rp. 31,130,122. While rock soil and dewatering diversion are Rp. 30,701,557. As well as sandbag diversions with dewatering of Rp. 61,831,679. The results of observations of the implementation time obtained the conclusion that the work of box culvert with sandbag diversion method takes 35 days, and rock soil diversion 49 days while dewatering 63 days. By time comparison the sandbag diversion method is 14 days faster than rock soil diversion, and 28 days compared to the dewatering method. From these data, it can be concluded that in terms of cost and time, the sandbag diversion method is more economical and efficient than the other two methods.

Keywords: box culvert, diversion, dewatering, cost, time

1. Introduction

Low geographical conditions and flowing by many rivers, as well as environmental problems, and the reduction of retention ponds in Jakarta, built reservoirs, where their function is to overcome problems such as flooding. Based on the schedule the work plan starts on September 13, 2019 and will end on December 12, 2019. But there was a delay until the 7th week the work took place. Job deviations reached 9.74 percent, while jobs that were delayed were Box Culvert jobs. One of the things that can be done in overcoming work delays is to choose the right implementation method, both in cost and time.

The method used in the box culvert work consists of three methods, namely the method of soil and rock diversion, the sand bag diversion method and the open pumping dewatering method. Diversion work is carried out to divert the flow of water contained in the work area during the excavation process until the installation of the box culvert. While dewatering is a process of drying certain areas which aims to control water which impedes the process of carrying out a construction work.

The work methods certainly have differences in their implementation, both in terms of cost and time. Based on the above, the researcher is interested in Analyzing the Cost and Time Comparison of the Diversion Method and Dewatering Of Box Culvert Work On The Cakung Timur Construction Of Reservoirs.

The formulation of the problem is needed so that the research has a direction in the process, then the formulation of the problem is needed that can be drawn from the identification of the problem, namely as follows:

1. How much is the comparison of the costs required to complete the box culvert work with the diversion method using piles of soil and rocks, the diversion method with sand bag, and the open pumping dewatering method?
2. How long does it take to complete the box culvert work with the diversion method using soil and rock deposits, the sand bag diversion method, and the open pumping dewatering method?

The purpose of this research is:

1. To find out the comparison of the costs involved in box culvert work, with soil and rock diversion methods, sand bag diversion methods, and open pumping dewatering methods.
2. To find out how much time is needed to complete the box culvert work, with the method of soil and rock diversion, the method of diversion with sand bags, and the open pumping dewatering method.

2. Literature Review

In general, reservoirs are places on the face of the land that function to store sufficient rainwater in the rainy season, so that water can be utilized in the dry season. Reservoirs are the output from the construction of dams, and are often called artificial lakes [1].

The construction of dams or reservoirs is one of the construction project activities. Project activities are temporary work that is limited by planned time and resources. Planned resources or project costs consist of direct costs and indirect costs. Direct costs are obtained by analyzing the unit price of work, namely the calculation of labor, materials and equipment to get the unit price or one particular type of work. Cost analysis consists of materials and wages [2].

Material analysis is to calculate the amount of each ingredient, as well as the costs needed for a job. While the wage analysis is to calculate the amount of energy needed to complete certain jobs [3].

Cost and time analysis in this study is the method of diversion and dewatering in box culvert work. Box Culvert channel is a drainage channel of reinforced concrete in the form of a box, has a connection in each segment so that it is waterproof. Diversion channel is a process to divert the flow of water in a channel not entering the work site. Making channel diversion is part of the drying work [4]. In this open pumping dewatering method what is done is by making a channel (sump pit) that has a lower surface than the surrounding excavation area [5].

3. Research Methodology

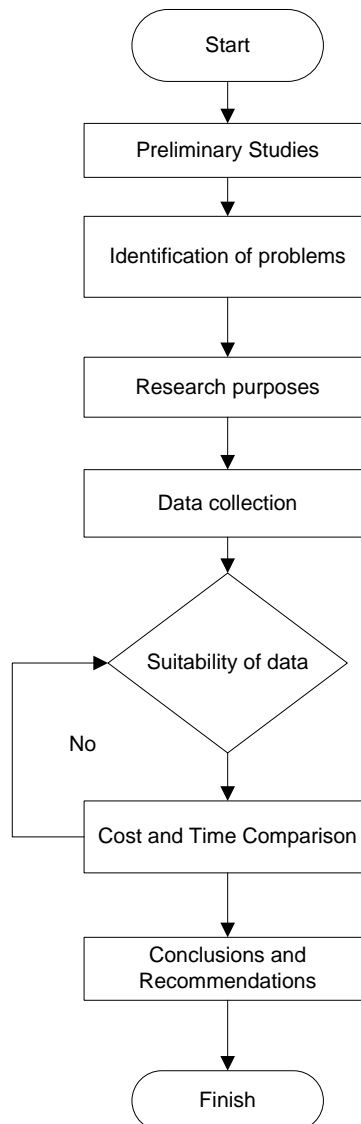


Figure 1. Research Flow Chart

Source: Processed Researcher, 2019

The methodology used in this study is by processing primary data from the results of the field survey, as well as gathering some information needed as secondary data.

Data processing and analysis is carried out based on the method of excel calculation and unit price analysis based on the Standar Nasional Indonesia (SNI) and PUPR Unit Price Analysis using the price of the DKI region. The final result of the analysis is the comparison of cost and time of the diversion and dewatering method.

4. Results and Discussion

The object of this study, the authors conducted a comparative study of the method of diversion and dewatering on cost and time.

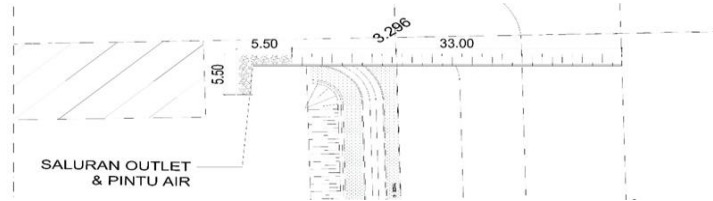


Figure 1. Outlet Channels

Source: Project Documents, 2019

The method of implementation is a systematic description of the implementation in the field in an appropriate manner and in accordance with work procedures. Following are the methods of implementing diversion and dewatering. The diversion method uses piles of soil and rocks, consisting of preparatory work, excavation work, embankment work, and finishing work. The working principle is to make the embankment half a part of the channel width so that a dry land is obtained which allows the construction to be carried out. Preparatory work on the rock soil diversion method includes land clearing and measurement work. In the implementation of this method work, as for the things that need to be done, namely the pile work which includes the work of procurement of rock soil material and the pile work itself. Laying sandbags layer by layer. Afterwards the local soil fill works will be relatively dry between the sand bags and compacted as needed.

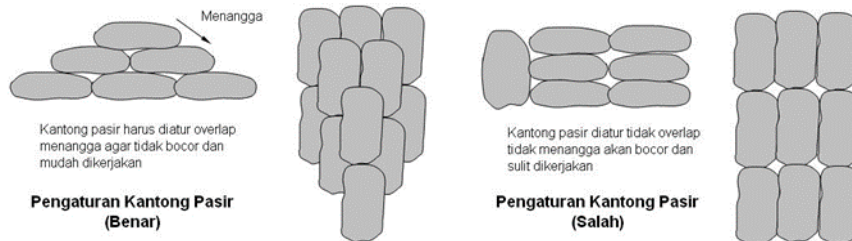


Figure 2. Correct and incorrect placement of staggered sandbag layers

Sourcer : CEMVP Flood-Fight Handbook, 2007

From the picture above can be seen how to arrange sand bag material. Broadly speaking, it can be explained that the method of sand bag diversion is almost the same as rock soil diversion, but in this method the sand bag material is placed in the excavation area to a minimum as high as the original land surface as a barrier.

Unlike the sand bag diversion and rock soil diversion, this open pumping dewatering method is done by making a channel (sump pit) that has a lower surface than the surrounding excavation area. Making sump pit aims to collect surface water from seepage of ground water and rain water. This method is carried out in conjunction with the excavation process of the area to be excavated.

4.1. Cost Comparison Analysis

Comparative analysis between methods is obtained by processing data obtained from the Cakung Timur Reservoir Construction Project, including volume, labor cost analysis, and AHS.

Table 1. Calculation Data

Description	Unit	Dimension
Length of embankment area	m	5,5
Fill height	m	2,0
Fill width	m	2,0
Sandbag dimensions	m	0,43 x 0,65 x 0,25
Bottom fill width	m	6
Lebar Timbunan Atas	m	2
Length of the drain	m	11,1
Width of the drain	m	0,3

Depth of the drain	m	0,3
Channel length	m	33
Channel width	m	1,5
Depth of the channel	m	2
Box culvert dimensions	cm	100 x 100

Source: Processed Researcher, 2019

From the results of calculations that have been carried out on the work of box culvert both diversion and dewatering methods, obtained volume data as follows:

Table 2. Work Volume of the Diversion & Dewatering Method

Description	Unit	Volume
Preparatory work	M	40,5
Rock and soil fill work	M3	22,00
Sandbag fill work	Bh	115,00
Dewatering	Hour	25,00
Soil diggings	M3	99,00
Lean concrete	M3	2,48
Box culvert channels	Bh	33,00
Landfill	M3	38,61

Source: Processed Researcher, 2019

After calculating the volume of work, the researcher analyzes the unit price for each item above, from the analysis results obtained direct and indirect costs as follows :

Table 3. Recapitulation of Direct Costs for Box Culvert Work

Description	Unit	Unit Price Of Rock and Soil Diversion	Unit Price Of Sandbag Diversion	Unit Price Dewatering Open Pumping
Preparatory work	M	25.400	25.400	25.400
Rock and soil fill work	M3	401.948		
Sandbag fill work	Bh	104.620	104.620	104.620
Dewatering	Hour		48.043	
Soil diggings	M3			13.732.065
Lean concrete	M3	706.603	706.603	706.603
Box culvert channels	Bh	5.667.106	5.667.106	5.667.106
Landfill	M3	361.423	361.423	361.423

Source: Processed Researcher, 2019

The cost calculation is done not only direct costs, but also indirect costs include costs incurred by the company outside of material, equipment and man power. The indirect costs are as follows :

Table 4. Recapitulation of Indirect Costs for Box Culvert Work

Description	Unit	Unit Price Of Rock and Soil Diversion	Unit Price Of Sandbag Diversion	Unit Price Dewatering Open Pumping
Staff costs	ls	51.000.000	34.000.000	51.000.000
Utility costs	ls	7.200.000	4.800.000	7.200.000
General cost	ls	21.020.360	17.589.460	24.900.660
Transportation costs	ls	4.900.000	3.500.000	6.300.000
Mobilization and demobilization	ls	15.000.000	15.000.000	32.000.000

Source: Processed Researcher, 2019

Recapitulation of direct and indirect costs of box culvert work as follows:

Table 5. Recapitulation of the Cost of Box Culvert Works for the Rock Soil Diversion Method

Description	Volume	Unit	Unit Price	Total Price
Direct Cost				
Preparatory work	40.50	m'	25,400	1,028,698
Rock and soil fill work	22.00	m3	401,948	8,842,845
Soil diggings	99.00	m3	104,620	10,357,420
Lean concrete	2.48	m3	706,603	1,748,841
Box culvert channels	33.00	m'	5,667,106	187,014,496
Landfill	38.61	m3	361,423	13,954,555
Indirect Cost				
Staff costs	1	ls	51,000,000	51,000,000
Utility costs	1	ls	7,200,000	7,200,000
General cost	1	ls	21,020,360	21,020,360
Transportation costs	1	ls	4,900,000	4,900,000
Mobilization and demobilization	1	ls	15,000,000	15,000,000
Direct Cost + Indirect Cost				322,067,215
PPH 3 %				9,662,016
Margin 10 %				32,206,721
The total cost of box culvert work				363,935,953

Source: Processed Researcher, 2019

Table 6. Recapitulation of the Cost of a Box Culvert Works for the Sand Bag Diversion Method

Description	Volume	Unit	Unit Price	Total Price
Direct Cost				
Preparatory work	40.50	m'	25,400	1,028,698
Soil diggings	99.00	m3	104,620	10,357,420
Sandbag fill work	115.00	bh	48,043	5,524,965
Lean concrete	2.48	m3	706,603	1,748,841
Box culvert channels	33.00	m'	5,667,106	187,014,496
Landfill	38.61	m3	361,423	13,954,555
Indirect Cost				
Staff costs	1	ls	34,000,000	34,000,000
Utility costs	1	ls	4,800,000	4,800,000
General cost	1	ls	17,589,460	17,589,460
Transportation costs	1	ls	3,500,000	3,500,000
Mobilization and demobilization	1	ls	15,000,000	15,000,000
Direct Cost + Indirect Cost				294,518,434
PPH 3 %				8,835,553
Margin 10 %				29,451,843
The total cost of box culvert work				332,805,831

Source : Processed Researcher, 2019

Table 7. Recapitulation of the Cost of a Box Culvert Work in Dewatering Method

Description	Volume	Unit	Unit Price	Total Price
Direct Cost				
Preparatory work	40.50	m'	25,400	1,028,698
Soil diggings	99.00	m3	104,620	10,357,420
Dewatering	25.00	hour	13,732,065	13,732,065
Lean concrete	2.48	m3	706,603	1,748,841
Box culvert channels	33.00	m'	5,667,106	187,014,496
Landfill	38.61	m3	361,423	13,954,555
Indirect Cost				
Staff costs	1	ls	51,000,000	51,000,000
Utility costs	1	ls	7,200,000	7,200,000
General cost	1	ls	24,900,660	24,900,660
Transportation costs	1	ls	6,300,000	6,300,000
Mobilization and demobilization	1	ls	32,000,000	32,000,000

Direct Cost + Indirect Cost	349,236,734
PPh 3 %	10,477,102
Margin 10 %	34,923,673
The total cost of box culvert work	394,637,510

Source : Processed Researcher, 2019

4.2. Time Comparison Analysis

The method used in determining the duration of box culvert work is field observations. How much time is needed to complete box culvert work. As for the results of field observations, the duration of time needed to carry out the box culvert work is as follows:

Table 8. Duration of Box Culvert Method Diversion & Dewatering Work

Work Method	Unit	Duration
Soil and Rock Diversion	Day	49
Sanbag Diversion	Day	35
Dewatering Open Pumping	Day	63

Source : Processed Researcher, 2019

Description of the duration of work required for each job as follows:

Table 9. Job Duration Box Culvert Description of the Diversion Method

Work Item	Unit	Duration
Preparatory work	Day	2
Mobilization and demobilization	Day	2
Land clearing	Day	3
Man power mobilization	Day	1
Soil diggings	Day	13
Sandbag material mobilization	Day	3
Sandbag diversion	Day	2
Soil and rock material mobilization	Day	3
Soil and rock diversion	Day	5
Lean concrete	Day	9
Box Culvert material mobilization	Day	7
Installation of culvert box	Day	7
Landfill	Day	7
Final work	Day	1

Source : Processed Researcher, 2019

Table 10. Job Duration Box Culvert Description of the Dewatering Method

Work Item	Unit	Duration
Preparatory work	Day	2
Mobilization and demobilization	Day	2
Land clearing	Day	3
Man power mobilization	Day	1
Soil diggings	Day	13
Temporary Water Reservoirs	Day	1
Temporary Channel Making Work	Day	1
Water reservoir hole	Day	1
Pipe Installation Around the Dewatering Area	Day	1
Dewatering	Day	20
Lean concrete	Day	9
Box Culvert material mobilization	Day	7
Installation of culvert box	Day	7
Landfill	Day	7
Final work	Day	1

Source : Processed Researcher, 2019

Based on the above analysis it can be concluded that of the three box culvert work methods, the duration required for the rock soil diversion method requires 35 days of implementation. While the duration of time needed to complete the box culvert work with the sand bag diversion method is 49 days. And for the box culvert dewatering method it takes 63 days to complete the work.

4.3. The Results

The results of the cost and time analysis of box culvert work from three methods namely rock soil diversion, sand bag diversion and open pumping dewatering obtained comparative data as follows:

Table 11. Comparison of Cost and Time of Box Culvert Work

Work Method	Duration (Day)	Total Cost (Rp)
Soil and Rock Diversion	49	363.935.953
Sanbag Diversion	35	332,805,831
Dewatering Open Pumping	63	394.637.510

Source : Processed Researcher, 2019

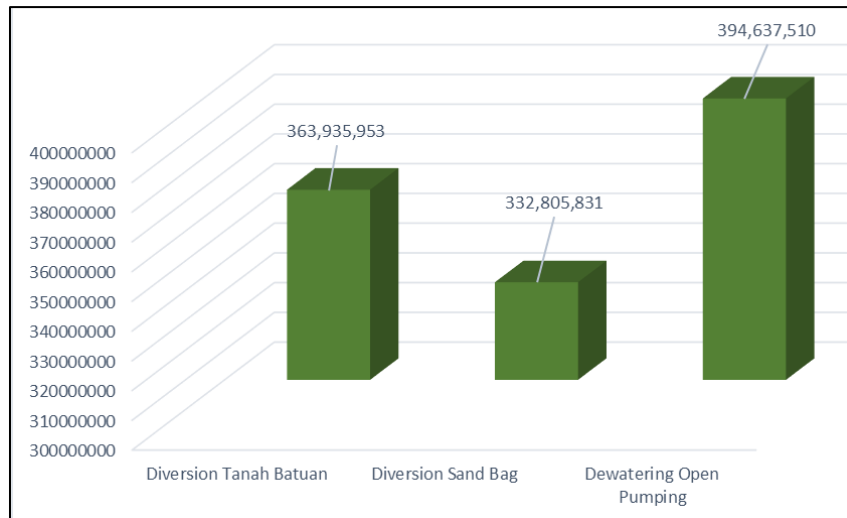


Figure 3. Comparison of Box Culvert Work Costs
 Source : Processed Researcher, 2019

5. Conclusions

Based on the results of research conducted related to the cost and time comparison of the methods of diversion and dewatering in the work of the box culvert construction project of the Cakung Timur Reservoir, it can be concluded as follows:

1. From the analysis results, the cost of implementing the rock soil diversion method in the box culvert work is Rp. 363,935,953, while the sand bag diversion is Rp. 332,805,831. And the cost of open pumping dewatering work is Rp. 394,637,510. The difference in cost of the sandbag and rock soil diversion method is Rp. 31,130,122. While the difference between the cost of the rock soil diversion method and dewatering is Rp. 30,701,557. And the cost comparison of the sandbag diversion method with dewatering is Rp. 61,831,679. From these data it can be concluded that in terms of cost, the sand bag diversion method is more economical than the other two methods.
2. Based on the analysis, it was found that the implementation time of the sand bag diversion method is 35 days, while the rock soil diversion takes 49 days and the dewatering method is 63 days. From these data it can be concluded that the sandbag diversion method is 14 days faster than rock soil diversion, and 28 days compared to the dewatering method.

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