# Application on Survey Implementation of Dredging and Structure for Energy Reducing Spillway Building at Ladongi Dam

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Abstract: The Energy Reduction Building planned at Ladongi Dam utilized the Type II Olakan Flat Pond Type (USBR II). Energy absorbers in spillway buildings are very important to reduce the energy of water flow and avoid damage to rivers. The purpose of this study is to determine the role of the survey in the implementation of excavation and also the structure buildings in the field and be able to process and present measurement data. Data field collection consists of 3 working stages: excavation work, working work floor and working wall structure. The calculation of excavation volume in this final project is carried out by measurement using the Cross Section and in volume calculation using the Mean Area method. The results from this study are, the role of the survey in the construction of energy reduction building, the volume of excavation and foundry of work floors, the dental importance of wall structures, cross-section, 3-dimensional view of excavated land. LW 33 block dental volume is 138.99 $m^3$ starting from an elevation of +60.11 to an elevation of +64.50. In Block LW 33 - LW 35, a landslide occurred in the zone 3 slopes parallel to the structural parapet (El. +64.5 - El. +67.5) therefore dental filling was carried out, the total required dental volume was 164,954 $m^3$. The total volume of excavation to the work floor elevation is 505,609 $m^3$, and the total volume of additional landslide structures is 893,329 $m^3$.

## 1 INTRODUCTION

Indonesia's rapid population growth makes the role of water sources significant. The volume of water is relatively fixed, but the water demand continues to rise, making humans continue to strive to manage water sources (Prastumi, 2012). One source of water that has the potential to be driven to reach the growing need for water is the river.

Judging from the geographical location and infrastructure of Southeast Sulawesi Province, East Kolaka Regency has an equitably large irrigation area and rivers that have the potential to irrigate agriculture, natural water sources, etc. One of the rivers in East Kolaka that can be exploited is the Ladongi River in Ladongi District. To take advantage of this potential, the Central Government through Sulawesi River Region IV Kendari Ministry of PUPR. Ladongi Dam is planned to have a capacity of 45 million $m^3$ and is expected to irrigate an area of 3604 ha.

The embankment dam was built by piling up materials such as a rock, gravel, sand, and soil in a unique composition with the function of to lift the water surface in the reservoir (Sosrodarsono, 1977), Ladongi Dam construction it was engineered to use the rock fill type dam. Ladongi Dam consists of several main building constructions, namely main Dam, spillway, and tunnel, each of which has an essential and interrelated role. Spillway buildings have the function to overflow water in dam reservoirs and to avoid overtopping on dams (Asiyanto, 2011). The spillway at Ladongi Dam uses Ogee type overflow type with light level elevation +119.8 meters. Ladongi Dam at spillway area consists of 4 main construction parts, namely flow control, launchers, energy absorbers, and drainage channels.



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The energy reducer building planned at Ladongi Dam uses the Olakan Flat Type II (USBR II) Pool type. This type is suitable for flow with high hydrostatic pressure and massive outflow (Sosrodarsono, 2016). Energy absorbers in spillway buildings are very important to reduce the energy of water flow and avoid damage to rivers. Damage that occurs is usually in the form of scouring on the river body caused by high energy content and supercritical flow due to changes in the slope of the dam lighthouse (Ratnawati, 2009). Therefore, before the flow of water flowing into the river, it has to slow down and changed in sub-critical flow conditions, so that no scouring occurs, which causes degradation on the riverbed (Prastumi, 2012).

In the implementation of the construction of the energy reducer structure has some factors that must be considered, such design structure, plan elevation, geological structure, and the strength of the slope structure. During the execution of the Ladongi Dam spillway, landslides have occurred at the slope structure in the launch area that caused by geological conditions in the area. The existence of landslides in the area resulted in changes in the method in the excavation process and the energy reducer structures.

The role of surveys is very important in the implementation of spillway work. In the field implementation, the survey team is generally tasked with determining location, controlling the excavation of structural work, and controlling the work of structures. The purpose of this study was to determine the role of the survey in the implementation of excavation and the structure of the Ladongi Dam energy reducer building, to know the handling and role of the survey in the landslide area of the energy reducer at Ladongi Dam. In this final project data collection is divided into 3 (three) parts, namely: excavation work, floor work, and wall structure work.

# 2 RESEARCH METHODS

## 2.1 Research Design

The results of the study are focused on providing a picture of the actual state of the object in the study. Stages of research to be carried out can be seen in Figure 1.

Data collection techniques used in this study were carried out by collecting primary data and secondary data. Primary data was obtained by collecting the data field directly through field observations and measurements. Secondary data in this study were obtained by the Office of the Ladongi Dam Supervision Consultant PT Binatama Wirawredha KSO PT Arga Pasca-Rencana and also by the Office Contractor PT Hutama Karya Bumi Karsa KSO.

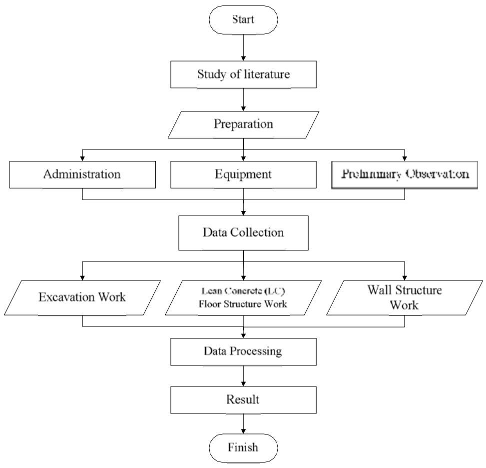


Figure 1: Research flowchart.

## 2.2 Research Location and Time

This research was conducted at Ladongi Dam Construction Project in East Kolaka Regency, Southeast Sulawesi Province, where the geographical location was on coordinates of 4° 08' 52" – 4° 08' 53" South latitude and 121° 52' 43" – 121° 53' 34" East longitude (Figure 2). In this study the location observed was an energy-absorbing building in an overflow building (Spillway). The data retrieval and processing last for 6 months.

## 2.3 Tools and Materials

In measurement activities, of course, equipment is needed to support this research activity in data retrieval and processing as follows:

- Software: Microsot Word 2010, Microsoft Excel 2010, Autocad Civil 2017, SketchUp 2017, Surfer 9.

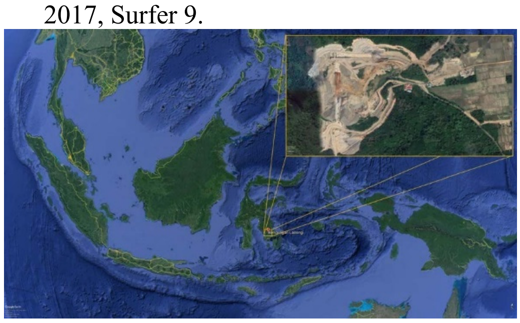

Figure 2: Research location.

- Hardware: Total Station Topcon ES 101, Waterpass Topcon AT-G6, Statif, Prisma, Bak Ukur, Meteran, Drone.

## 2.4 Dredging Works

Dredging work is the initial stage in carrying out the work of a building structure, where this excavation work is carried out to provide land for the building structure. Stages of dredging works can be seen in Figure 3.

Before the work is carried out, there are preparatory stages that need to be considered to support the implementation of work in the field from start to finish such as Provision of Data and Working Drawings, Inspection of Survey Equipment, and mobilization of Personnel Equipment. In excavation work, some main things must be considered as follows:

- Point Benchmark (BM), the initial stage in carrying out survey work in the field surveyors need to have Benchmark data (BM). BM has a fixed position value in the form of coordinates with the appearance of a monument/pale in the field, which is used as a reference point (Adi & Aghastya, 2017). BM procurement can be done by measuring using Geodetic GPS through the static method or using local coordinates. In this study, the procurement of BM points was not carried out because the reference points of BM were evenly distributed in the research location.
- A Mapping Situation is a mapping activity to get a detailed description of the work area project (Susetyo, Tri, & Saputra, 2013). The measurement for mapping is discovering the horizontal position and vertical position of each point in the field (Kustarto, 2012). The mapping situation in this study concerns for carried out to find how the topography before the excavation stage and also use as a factor of data field checking based on the design drawings.
- Excavation stage, implementation on the field for excavation work begins with the determination of the excavation location. Fixing the area of the excavation is done by stake out the coordinates and marking the land boundaries. The coordinate stakeout is to select the point above the earth's surface using the coordinates [9], the coordinate stakeout can be done by using the Total Station. If the excavation location has been decided, excavation work can be started. One of the obstacles that occur during the excavation in the field is some areas have the potential for landslides, so during the excavation stage, if a landslide occurs, it is necessary to handle it by installing a counterweight.

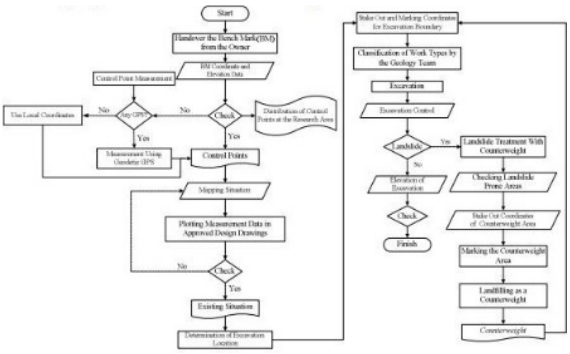


Figure 3: Dredging work flow chart.

## 2.5 Work Floor Work

In the implementation of the work floor of a building structure, the availability of the work floor structure land must be ensured. Figure 4 is the following stages in work floor activity.

Measurement of detail points is needed to describe the situation of the measurement area in more detail, measurement of detail points can be done using the tachymetry method. The tachymetry method is a measuring method of detail points used in determining the coordinates and height of the detail points from tie points (Maulidin, 2016). Measuring height or elevation is the measurement of the height difference between two points.

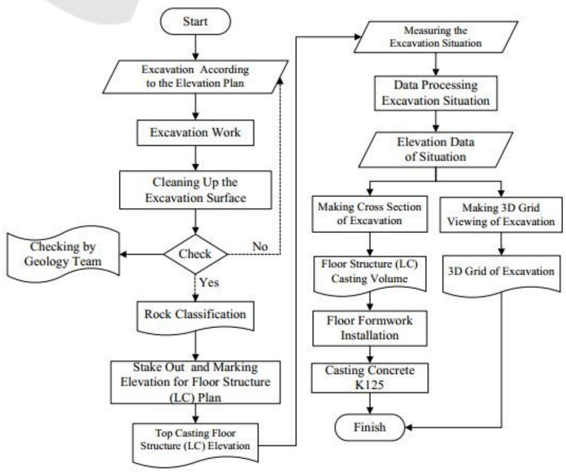


Figure 4: Work flow chart of floor.

Measurement of height difference can be done with a flat slope measurement tool, measuring the height difference with a flat slope is the process of determining elevation or finding a different height between measured points (Masrul & Anjasmara, 2015). The role of the survey is to ensure that the excavation area and/or work floor elevation are following the plan. If the excavation has matched with the design elevation plan, the geological team will check to ensure that the excavated land as compared to the specifications with planning design by the geological team, height between measured points (Masrul & Anjasmara, 2015). The role of the survey is to ensure that the excavation area and/or work floor elevation are following the plan. If the excavation has matched with the design elevation plan, the geological team will check to ensure that the excavated land as compared to the specifications with planning design by the geological team.

- Stake out elevation and work floor marking, stake out elevation is to determine the point that will be the elevation limit of the work floor plan if the excavation of the land has passed the work floor plan design (Figure 5). In the implementation of stake out, fixing and checking reference points is the first step that must be taken (TS-04, 2011). To fix the work floor elevation limit, it can be fixed by using measurement tools, i.e. water pass, the accuracy of deter- mining the size depends on the tools used as well as on the accuracy of measurement and what can be executed (Frick & Heinz, 1984). After obtaining the work floor elevation limit, the work floor boundary marking is carried out to obtain the work floor top cast. The implementation of stake out elevation in the field is carried out using the formula below, i.e:

$$RefEle(A)WP = RefEle(A) + RefSigns(A) \quad (1)$$

$$SignsRead(B) = RefEle(A)WP – CastTEle(B) \quad (2)$$

- The excavation situation was measured using wa- ter pass and meter. Water pass is used to get full cast from the work floor and work floor bound- aries (Figure 6). Excavation situation data is taken by cross technique taken per 1 meter. Through the measurement of the excavation situation, it can be seen how the cross-section of excavated land is through the results of the profile lengthwise and the transverse profile.

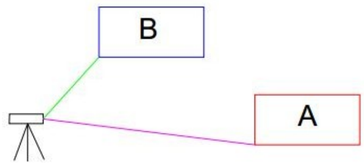


Figure 5: Stake out and work floor elevation marking techniques.

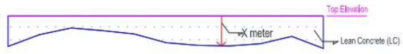


Figure 6: Data retrieval technique for dredging situation.

The results of this measurement will be processed to obtain the volume of work floor casting using the cross-section method with the Mean Area equation with the following formula (Adi & Aghsatya, 2017):

$$V_1 = \frac{A_1 + A_2}{2} \times L \quad (3)$$

$$V_n = \frac{A_n + A_{(n+1)}}{2} \times L \quad (4)$$

Where:

$V_n$ : nth section average volume ($m^3$),
$A_1$ : Cross-sectional area 1 ($m^2$),
$A_2$ : Cross-sectional area 2 ($m^2$),
L : Distance between each section (m).

Figure 7 is the stage of the wall structure work, which is the final stage in developing the energy reducing construction. Stakeout and marked elevation of the nth section from wall design, Stakeout elevation or vertical stakeout is the measurement of the main points position and the vertical details of the building. The first step is, of course, the determination of the foundation elevation at a predetermined location through the measurement of horizontal stakeholder outs. After determining the elevation of the working wall plan, estimation of the volume of concrete needed for casting can be estimated. If landslides occur in the wall structure area, the need for concrete for casting will increase. The landslide result, fillings and/or dental casting are carried out to cover the landslide area so that the initial concrete requirements according to the plan based on the work drawings are added to the volume of the landslide. Calculating volume of the landslide, the survey team took measurements of the situation of the landslide area, in this measurement using a meter by calculating the distance between the structure of the building and the area affected by the landslide.

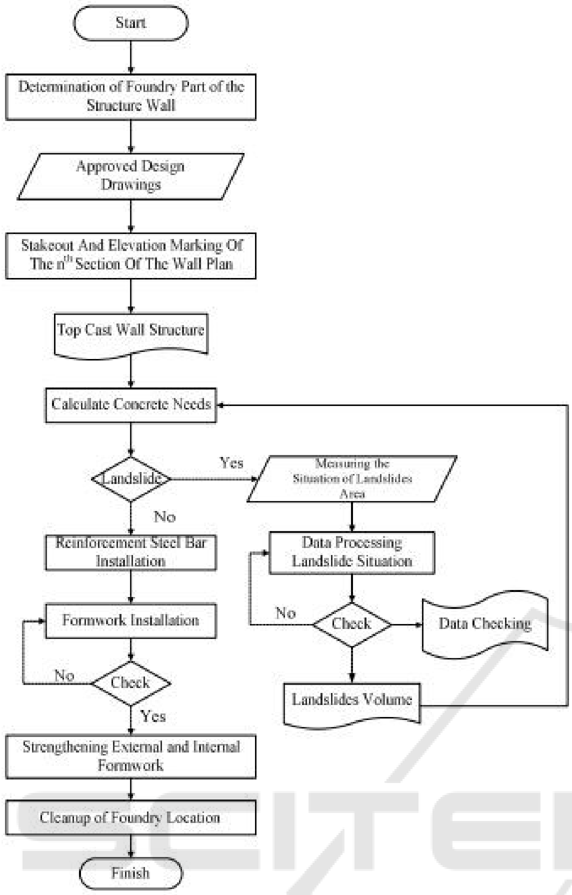


Figure 7: Structure work flow diagram.

# 3 RESULTS AND DISCUSSION

## 3.1 Dredging

The excavation process begins with a stakeout and marking the boundaries of excavated land to be worked. Excavation work for wall structure work floors is carried out up to +54.00 m elevation, while elevations for work floors are required up to +55.00 m elevation.

In the excavation work, the survey team has the role of controlling the excavation to ensure that the excavation is following the design elevation. In the field implementation, there were obstacles in the form of landslides during the excavation process. Therefore, it is necessary to handle landslides by installing counterweights (Figure 8). A counterweight is a pile of soil that is made at the slope, and the functions are to prevent scouring and provides counter forces that restrain soil movement so it can increase the value of the safety factor (Kusuma, 2014). In handling and preventing landslides, the survey team play a role within plotting the boundaries of the land area that will be installed by counterweights.

## 3.2 Survey of Employment on Floor of Work

The role of the survey in this work flooring initially begins with ensuring the elevation of excavation matches the work drawings and also controlling the excavation again when over-excavation is needed to obtain the appropriate rock type. Checking the work floor elevation is ensured by conducting stake elevation. Stakeout elevation is to determine the point that will be the elevation limit of the work floor plan if the excavation of land has passed through the work floor plan design.

After obtaining the work floor elevation limit, the work floor marking is carried out in order to obtain a work floor top cast. After getting the top cast work floor, the next step is to measure the dredging situation.

## 3.3 Work Floor Dredging Volume

Through the measurement of the excavation situation, it can be seen how the cross-section of the excavated land is and can be calculated cast volume for the work floor. The calculation for the volume of work floor casting is using the method of cross-section or cross profile. A cross-section is a vertical section or a section perpendicular to the project axis (Wijayanto, Sunarjono, Abdurrosyid, 2013). The work floor elevation for the Right Wall (RW) and Left Wall (LW) wall structure is at +54.00 m elevation while the Center Floor (CF) elevation is at +54.00 m for footing and +55.00 m for work floor. The elevation is used as a casting reference or commonly called Top Cast for the marking limit of work floor elevation when there has been over-excavation so that the land is cast to match the elevation of the work floor design.

In the field implementation, the average length of excavation was 6.90 meters, and the width of the LW 32 excavation block was 4.75 meter. Figure 9 shows the results of the long section profile and one of the results of the cross-section. Block LW 32 is divided into 6 cut lines or 6 crosses starting from 0 meters at the start of the block with a per-cross distance interval of 1 meter and the last cross continuing from the end of the block boundary about 0.75 meters.

Figure 8: Counterweight installation.

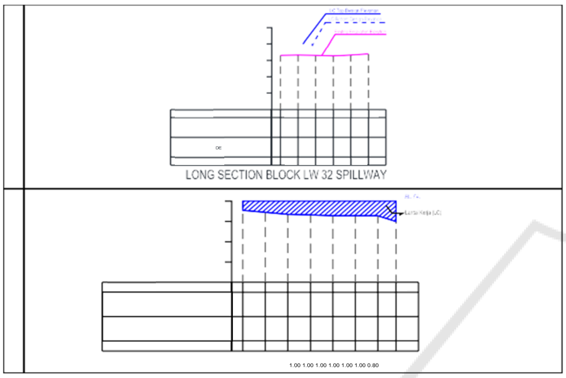


Figure 9: Situation profile of the spillway block LW 32 LW.

The elevation of the cast top floor of the LW 32 block is at +54.00 m. The highest excavation elevation is +53.60 m with a difference in height difference of 0.40 meters from the elevation of the top cast, for the lowest elevation at +52.95 m with a difference of 1.05 meters from the top cast elevation. The volume of casting on the LW 32 Block's work floors was 22,345 $m^3$.

Based on Figure 10, it can be seen the visualization of the 3d grid showing the situation of the LW 32 Block excavation surface. The results of excavation show that various elevations are caused by soil surface geological factors. The number of working floor blocks in this study was 15 blocks, total volume from excavation to the work floor elevation was 505,609 $m^3$, and the highest volume was in the LW 35 Spillway block of 63,854 $m^3$.

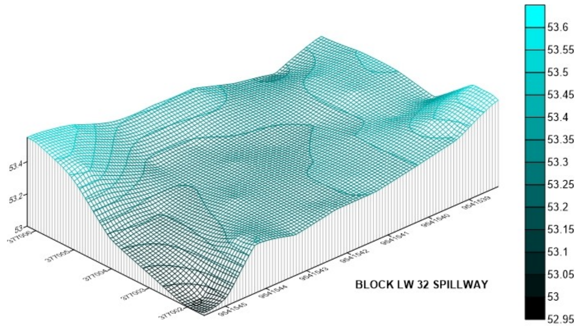


Figure 10: 3D grid viewing block LW 32 spillway.

## 3.4 Field Survey in Wall Structure

In the implementation of the building, structure work is done in stages, usually, the work on the structure is done by dividing it into several segments. The Ladongi Dam damper structure works are separated into 4 segments. Segment 1 is at an elevation of +55.00 m, segment 2 is at an elevation of +56.00 m, segment 3 is at an elevation of +64.50 m, and segment 4 is at an elevation of +67.50 m. The segmentation is carried out to simplify the process of ironing, installing formwork, and also the process of casting the building structure.

In the excavation and also the structure work of the energy-absorbing building walls, landslides occur around the LW 33, LW 34, and LW 35 blocks. The existence of landslides is caused by geological factors in the area and the potential for landslides on the slope above the building plan structure. The consequence of the landslide occurred, dental fillings and/or casting were carried out to cover the landslide area, so that the original concrete requirements according to the plan based on the design of the drawing were calculated to the total volume of landslides. In calculating the volume of the landslide, the survey team had to measure the situation of the landslide area. This measurement was using meters by measuring the distance between the edge of the building structure and the area affected by landslides.

In collecting the landslide data at block LW 34 Spillway, it was carried out by dividing it into 5 crosses starting from the 0 meters from the first block and the interval distance for each cross is 2.5 meter, the landslide cross measurements can be seen in Figure 11.

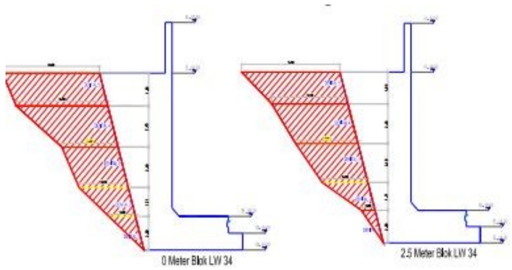


Figure 11: Cross landslide measurement block LW 34.

Dental casting for the LW 34 Spillway Block Avalanche area is divided into 5 segments, namely Dental 1, Dental 2, Dental 3, Dental 4, and Dental 5. Segment Dental 1 is at an elevation of +54.00 m to an elevation of +56.00 m, Segment dental 2 is at elevation +56.00 m to an elevation of +57.71 m, Segment dental 3 is at an elevation of +57.71 m to an elevation of +60.11 m, Segment dental 4 is at an elevation of +60.11 m to an elevation of +62.54 m, and the segment dental 5 is at an elevation of +62.54 m up to +64.50 m elevation. The dental volume for casting the landslide area of the LW 34 Spillway Block was 347,959 $m^3$.

The location of the energy reducing structure is right under the slope of zone 3 spillway, and there was a landslide right to the building structure on Block LW 33 to Block LW 35 (El. +64.5 - El. +67.5). To prevent further landslides in the slope area that can affect structural damage and hinder other work, so to prevent further landslides and establish the structure, patching of the landslide area is carried out using dentals. Cross landslide measurements are carried out starting from the LW 33, LW 34, and LW 35 blocks together. The number of crosses is 22 crosses and starting from the first 0 meters of LW 33 Spillway Block, and with 1-meter intervals between each cross, the results of cross landslide measurements can be seen in Figure 12.

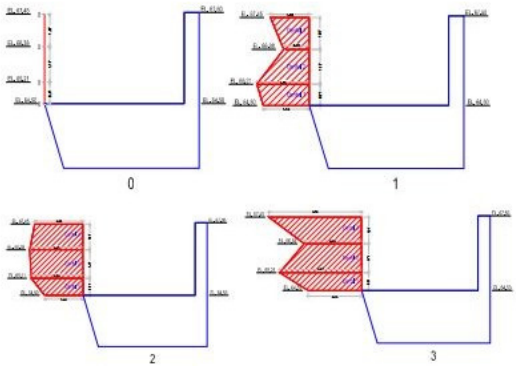


Figure 12: Cross Landslide Block LW 33, 34, 35 (+65.21 - +67.45).

Dental casting for the landslide area LW 33 Block – LW 35 Spillway Block is divided into 3 segments, namely Dental 1, Dental 2, and Dental 3. Segment Dental 1 is at an elevation of +64.50 m to an elevation of +65.21 m, and segment Dental 2 is at elevation + 65.21 m to an elevation of +66.38 m, the Dental 3 segment is at an elevation of +66.38 m to an elevation of +67.45 m. The volume of LW 33, LW 34, and LW 35 Spillway block dental casting is 164,945 m3. The total volume of additional landslide structures is 893,329 $m^3$.

## 4 CONCLUSIONS

Handling of landslides is done by installing counterweights in areas affected by landslides, and those have the potential for landslides. The results from the excavation situation measurement are used to calculate the volume of the work floor casting using the Mean Area equation. The total excavated volume of elevation of the work floor is 505,609 $m^3$. The LW 33 Block dental volume is 138.99 m3 starting from +60.11 elevation to +64.50 elevation. In Block LW 33 there was a landslide in zone 3 slopes parallel to the structural parapet (El. + 64.5 - El. + 67.5) then dental filling was made, the total dental volume needed was 164,954 $m^3$.

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## REFERENCES

Adi, W. T., Aghastya, A, 2017. Penggunaan total station dan autocad civil 3D untuk perencanaan grading. *Jurnal Perkeretaapian Indonesia*.

Asiyanto, I, 2011. *Metode Konstruksi Bendungan*, Penerbit Universitas Indonesia (UI-Press). Jakarta.

Frick, I., Heinz, 1984. *Ilmu dan alat ukur tanah,* Penerbit Kanisius. Semarang.

Kustarto, D. H., 2012. *Ilmu ukur tanah metode dan aplikasi: bagian kedua*, Penerbit Dioma. Malang, 1st edition.

Kusuma, R. C., 2014. *Evaluasi Desain Tahap 1 Disposal Swd 11 Pit*.

Masrul, Anjasmara, I. M., 2015. *Pemantauan penurunan muka tanah di kawasan Watukosek menggunakan metode sipat datar*, Geoid.

Maulidin, R. F., 2016. *Studi penentuan volume dengan total station dan terrestrial laser scanner*, Institut Teknologi Sepuluh Nopember.

Muda, I., 2008. *Teknik Survei dan Pemetaan*, Direktorat Pembinaan Sekolah Menengah Kejuruan. Jakarta.

Prastumi, 2012. Pengaruh variasi tipe peredam energi terhadap karakteristik hidrolika saluran pelimpah bendungan studi kasus uji model pelimpah bendungan Jehem—Bali, *Rekayasa Sipil*, pp. 153- 160.

Program Studi Teknik Geologi Tambang Batubara Distrik Baya Desa Separi, Kecamatan Tenggarong Seberang, Kabupaten Kutai Kartanegara, Kalimantan Timur. *Geological Engineering E-Journal*.

Ratnawati, H., 2009. *Pelimpah bertangga sebagai peredam energi pada kolam olak tipe solid roller bucket*, Universitas Muhammadiyah Surakarta.

Sosrodarsono, D. I., 1977. *Bendungan type urugan*, PT. Balai Pustaka (Persero). Jakarta, 4th edition.

Sosrodarsono, D. I., 2016. *Bendungan Urugan*, PT. Balai Pustaka (Persero). Jakarta, 6th edition.

Susetyo, D. B., Tri, H., Saputra, L. R., 2013. *Standarisasi Aplikasi Survey Pemetaan Terestris Dalam Bidang Konstruksi Struktur Bawah Bangunan*.

TS-04, M., 2011. *Melakukan stake out dan monitoring: materi pelatihan berbasis kompetensi sektor konstruksi sub sektor bangunan gedung*.

Wijayanto, H., Sunarjono, S., Abdurrosyid, J., 2013. *Pengaruh Ketelitian Hasil Pengukuran Topografi Terhadap Desain Irigasi Gonggang*, Universitas Muhammadiyah Surakarta.