APPLICATION OF ROBOTIC ONLINE BASED ON WEBSITE TO MONITORING OF DAM CASCADE SURFACE DEFORMATION SYSTEM

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ABSTRACT

The dam is a multifunctional construction that was built to withstand the flow of water which has an important for human life. A building if under pressure will changes in dimensions or shape. This also affects the dam. If the dam's body gets pressure from the effects of lake water loading, It has the potential to deform. The dam need planning and schedule maintenance by monitoring deformation regularly. This is related to the Sorowako Region which is an area prone to earthquakes due to the presence of Matano fault and Palu koro fault which could have an impact on the failure of the existing dam structure in the area. The dam need deformation monitoring system in real time using a threedimensional and one-dimensional sensor for both static and dynamic movements is very important.

As the first step of application of the station active GPS/GNSS – CORS (Global Positioning System/Global Navigation Satellite System-Continously Operating Reference Station) has been implemented first At the Karebbe Dam and continued in the Batubesi Dam and Balambano Dam which is the dam cascade system owned by PT. Vale Indonesia in East Luwu District, South Sulawesi Province. The use of Geodetic Monitoring Systems (Geomos) is a technology based monitoring system with the latest in speed, accuracy, reliability and effectiveness with very little human error in the activities of measurement and monitoring of dams. The measurement results can be obtained data and visual information in real time, complete and can be accounted for scientifically with the manual of the measure.

1. INTRODUCTION

1.1 Overview

PT Vale Indonesia Indonesia, TBK (PT Vale Indonesia), formerly known as PT Inco, is a mineral mining company that produces nickel as its main product. PT Vale Indonesia Indonesia operates in East Luwu District, South Sulawesi. In this area there are three interconnected lakes flowing from upstream to downstream through the Larona River which rises in the Gulf. Larona River basin Area (DAS) with an area of 2,477 km2 which contains 3 lakes, namely Lake Matano, Mahalona and Towuti is a strategic WATERSHED as a provider for three hydroelectric power (PLTA) that supplies electricity needs in the area PT Vale Indonesia's nickel mining and surrounding areas. The Total installed power in the three PLTA was 420 MW, consisting of Larona PLTA with installed power of 3 x 60 MW, PLTA Balambano with installed power 2 x 65 MW and PLTA Karebbe with built-in power 2 x 55 MW, the three of which are cascade systems. The Batubesi Dam is located about 15 km from the upstream of the Balambano dam or about 20 km from the Karebbe Dam. The Balambano Dam is about 5 km upstream of the Karebbe dam.

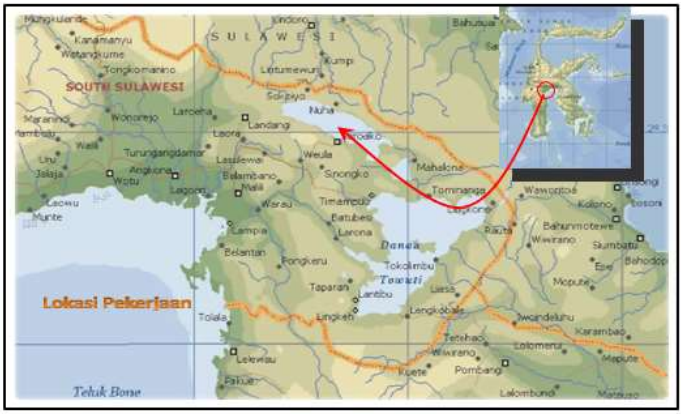

Figure 1 : PT. Vale Indonesia of mining company location

1.2 Dam cascade

Larona River basin Area with an area of 2,477 km2 which contains 3 lakes, namely Lake Matano, Mahalona and Towuti is a strategic watershed as a provider for three hydroelectric power that supplies electricity needs in the area PT Vale Indonesia's nickel mining and surrounding areas. The Total installed power in the three hydropower was 420 MW, consisting of Larona hydropower with installed power of 3 x 60 MW, Balambano hydropower with installed power 2 x 65 MW and Karebbe hydropower with built-in power 2 x 55 MW, the three of which are cascade systems. The Batubesi dam is located about 15 km from the upstream of the Balambano dam or about 20 km from the Karebbe dam. The Balambano dam is about 5 km upstream of the Karebbe dam.

Figure 2 : Dam location

2. PURPOSE AND OBJECTIVES

2.1 Background

The territory of the Republic of Indonesia is at the clash of three crust plates namely the Eurasian Plate, Pacific plate, and Indian-Australian plate and when we geologically review the territory of the Republic of Indonesia is at the meeting of 2 earthquake lines The Pacific earthquake and Transasiatic earthquake line, seeing this condition, the movements of the Earth's surface are sourced from the activity

Volcanoes and earthquakes are a very common occurrence. Sorowako itself includes earthquake prone areas due to the existence of Matano fault and Palu Koro fault that could have an impact on the failure of the building structures in the area. The last earthquake felt strong enough to occur on September, 28 2018 at 18:02:45 pm with the epicenter at 26 km north of Donggala – Central Sulawesi and into 11 km. The distance from the epicenter to The Batubesi Dam is 323.85 km, The Balambano Dam is a 313.15 km and Karebbe Dam is 311.77 km. This affects the infrastructure positions such as dams, bridges, tall buildings, air ports, and sea ports, and it is necessary to obtain intensive monitoring so that the functions of the infrastructure can be maintained.

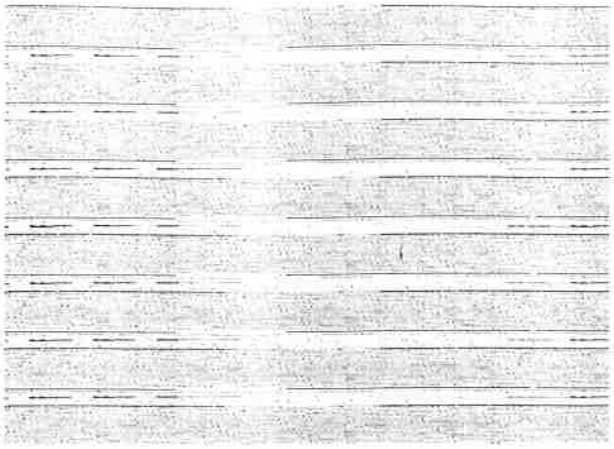

Figure 3 : Distance Of Donggala earthquake to Batubesi dam

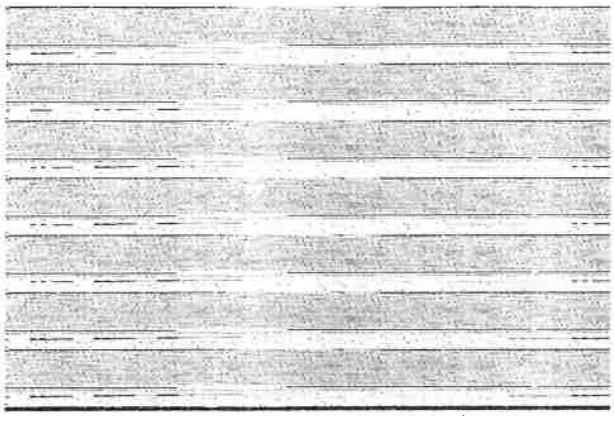

Figure 4 : Distance Of Donggala earthquake to Balambano

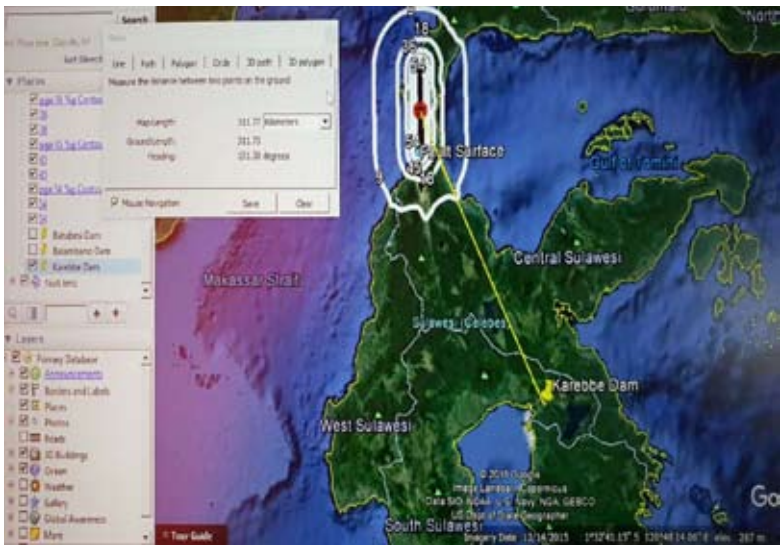

Figure 5 : Distance of Donggala earthquake to Karebbe

The need for a dam deformation monitoring system in real time using a three-dimensional and onedimensional sensor for both static and dynamic movements is crucial. As a trial step, an activity implementation of the dam-based deformation monitoring technology for GPS/GNSS-CORS (Global Positioning System/Global Navigation Satellite System-Continously Operating Reference Station) was implemented in 3 PTVI dams in Laskap Village, Malili Sub-district, East Luwu Regency, South Sulawesi Province.

The use of Geodetic Monitoring Systems (Geomos) may be considered as a step forward in the latest technology-based dam monitoring system, which has speed, accuracy, reliability and effectiveness with very little Human error in dam measurement and monitoring activities. As it is known that the dam body will experience pressure from the loading effect of Reservoir dam. As a result of this pressure force, dam body will likely be able to undergo deformation. Because the dam has a very important role for people's life, it is necessary to maintain adequate maintenance and maintenance to avoid damage to the dam.

Form of maintenance and treatment is one of them is by monitoring the deformation on the body of the dam. Monitoring of deformation in the dam body must be carried out periodically and continuously, periodic monitoring, repeated observation methods and recording of the behavior of dams with the help of instrumentation or other equipment, Data results Monitoring can depict the behavior of a dam, so the symptoms may be known early. Repeated and continuous retrieval of data is very vulnerable to human error this is because data retrieval is done in bulk and continuously at the same location. The method of measuring manually at this time is not able to answer the need for speed calculations and analysis of rapid results. It takes data retrieval method automatically.

Main purpose of using Geomos is:

1. Online and automatic Monitoring of 24 hours, continuously, for the acceleration of early warning information when there are things that are considered dangerous.
2. Observe the movement of detail in the main structure with 3D robotic sensors, and in combination with other existing 1-2D digital sensors.
3. It can provide early information for maintenance, maintenance, with accurate data to save maintenance costs.
4. Increase safety for humans, as a concern for the environment.
5. Reducing the impact caused by disasters.

The things to note in implementing the installation of Geomos are :

1. Consultation for system design, adapted to objects and locations selection of location-location monitoring point (by expert), Main monitoring station, reference (Stable), critical point in dam body structure, critical point in wide location (around DAM).
2. Procurement Hardware and software setup supporting facilities: Home appliance, power supply, security, prism, pillars etc. Installation of measuring instruments, communication tools and software system settings, testing, setting to get maximum accuracy results.
3. Analysis: Data analysis, limit determination, early warning (by competent experts) care for all systems: software maintenance, hardware calibration, service etc.

2.2 Purpose and objectives

This activity is an implementation of early warning system or early warning which is intended to anticipate the occurrence of deformation, which caused by earthquake among others can increase the deformation of dam body, such

as A horizontal shift, drop or settlement of deposits, avalanche or sliding that is beneficial to keep the safety of the citizens living around the building, and infrastructure. In order to support the implementation of the dam deformation monitoring equipment or infrastructure that will be installed in the Karebbe Dam is required to support reliable data communication system. Considering the location of equipment or monitoring infrastructure of dams scattered at several points in the area of the PTVI Dam and monitoring system that must be accessible by the management Utilties PT. Vale Indonesia, then it is necessary to design data communication And according to the needs of the deformation monitoring system on the dam that will be implemented.

The goal of this is to be a monitoring activity in order to be anticipated prevention of disaster caused by deformation due to the movement of the dam horizontally or vertically due to the movement of Dams such as earthquakes, avalanches, leaks, etc., through information systems obtained continuously and real time. In addition, the monitoring method is performed simultaneously using several sensors both static and dynamic and in certain places installed Video System using Internet Protocol (IP) Camera. Data monitoring results are formed in a single system that is easily accessible by stakeholders.

3 DISCUSSION

3.1 Monitoring dam deformation

The monitoring of dam deformation is essentially observing the 3-dimensional movement (movement in the x, Y and Z axes) at several pre-defined observation points. Monitoring is performed by a tool called Robotic Total Station. The device performs observations from the monitoring station by measuring the periodical distance of the observation points and processing them into the data and information of the measuring point movement.

Examples before the Robotic online monitoring was installed, the measuring of monitoring the crest survey at DAM Karebbe was conducted by Team Geotechnical Survey of the Department of Mining by using Theodolit tool. The capture of the Crest Dam movement also looked at 3 dimensions, namely (Easting, Northing, and Elevation). The watchpoint taken amounted to 18 points with the original reference as shown in the table below.

Table 1 : Survey point of Karebbe dam reference

	Station	Easting	Northing	Elevation	Distance
Setup	RB	500.000	1000.000	99.174	
Backsight	LB	500.000	1254.140	95.415	
Setup	HPRB	503.524	1015.582	91.754	
Backsight	LB	500.000	1254.140	95.415	
Original	CM.1	512.653	1032.060	83.602	20.526
Original	CM.1	512.653	1032.060	83.602	20.526
Original	CM.2	499.995	1056.034	81.688	58.699
Original	CM.3	499.995	1057.029	81.636	59.665
Original	CM.4	499.998	1074.853	80.225	77.214
Original	CM.5	499.999	1075.843	80.165	78.189
Original	CM.6	499.999	1100.004	79.537	101.914
Original	CM.7	499.998	1100.991	79.545	102.881
Original	CM.8	500.000	1119.038	79.536	120.647
Original	CM.9	500.001	1120.041	79.528	121.638
Original	CM.10	500.000	1138.931	80.275	140.211
Original	CM.11	500.000	1139.934	80.318	141.199
Original	CM.12	499.995	1175.935	80.351	176.939
Original	CM.13	499.995	1176.935	80.341	177.934
Original	CM.14	499.996	1199.078	79.531	200.045
Original	CM.15	499.997	1200.072	79.523	201.035
Original	CM.16	499.999	1217.959	79.530	218.842
Original	CM.17	500.003	1218.942	79.522	219.822
Original	CM.18	500.000	1240.214	79.552	241.014

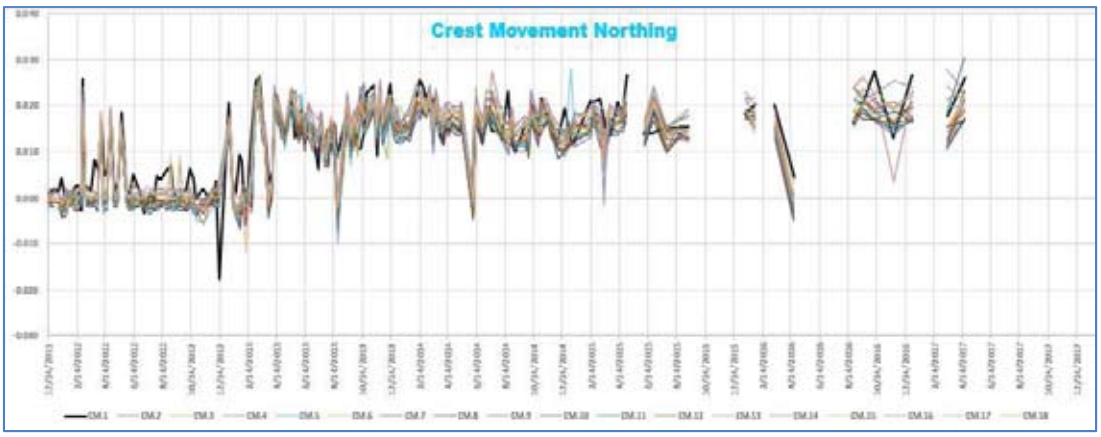

Figure 6 : Crest movement northing of Karebbe dam

Figure 7 : Crest movement easting of Karebbe dam

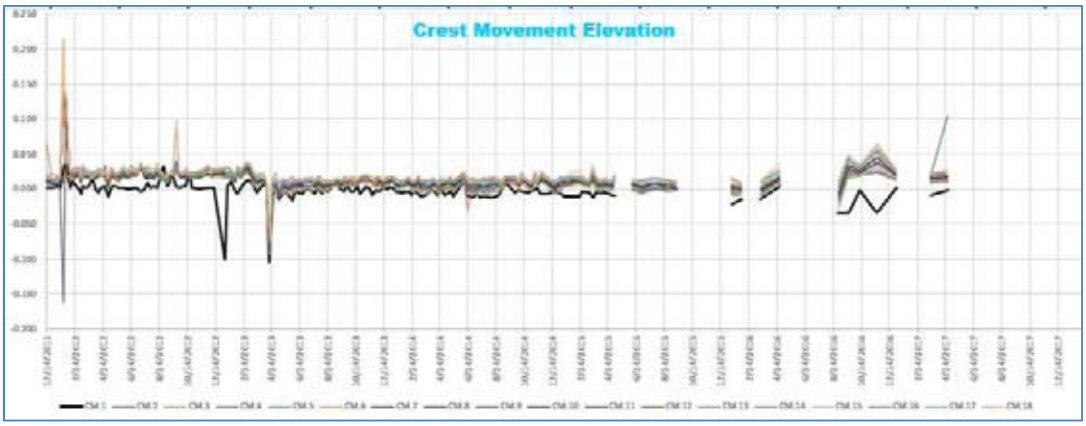

Figure 8 : Crest movement easting of Karebbe dam

Data retrieval survey by quality team survey of mining intensive enough, this data retrieval can be done every week or 4 times a month. But as time goes by more work in the mining department, the intensity of data retrieval starts to decrease up to three months such as deviation in the graph of monitoring results of crest movement above. The dam deformation monitoring is a very important thing to monitor the safety of dams managed by PTVI. This is also the strong reason of PT. Vale Indonesia to install the robotic online monitoring in the dam body.

The Robotic monitoring station itself is placed at a certain distance to the observation points. The observation point is a position in the dam body and at that point placed a prime observation. Robotic Total Station will emit/fire the laser beam toward a prime and capture the laser beam reflected by the prism and process it into the distance data or the position of the prism relative to the Robotic monitoring station. This process is done for a number of 18 prisms that are placed at the points of the damin-body measuring points and 7 prism on the left bank of the dam with periodic and automatic repeated measurements. Link communication to the server using the FO connected with Lantronix. The total station Robotics plan performs measurements every 30 minutes.

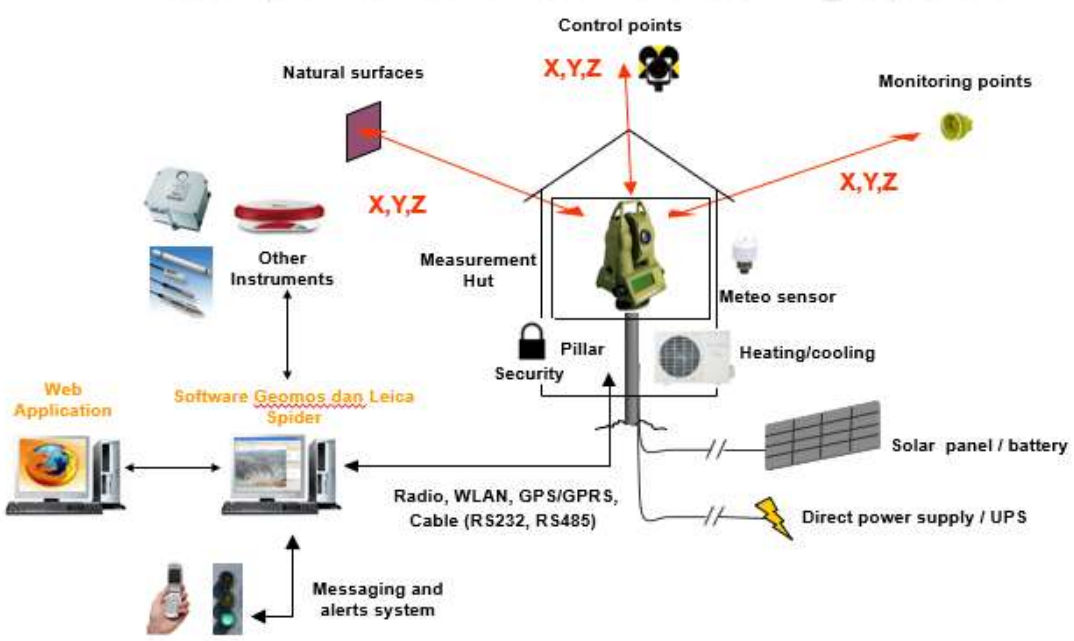

Figure 9 : Robotic system monitoring online

Figure 10 : Equipment point at Karebbe dam

Figure 11 : Robotic shelter position

Figure 12 : GPS and prisma position

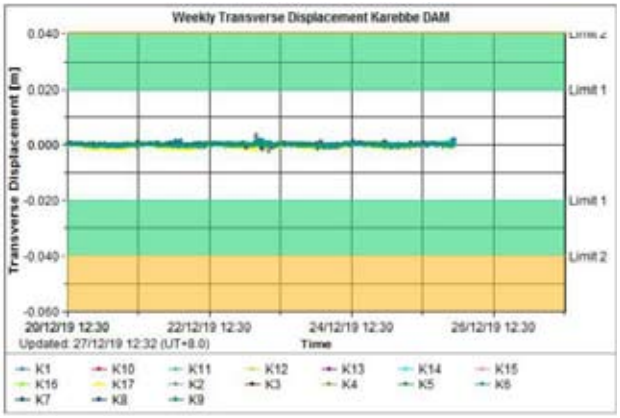

Figure 13 : Karebbe Robotic crest movement transverse graph

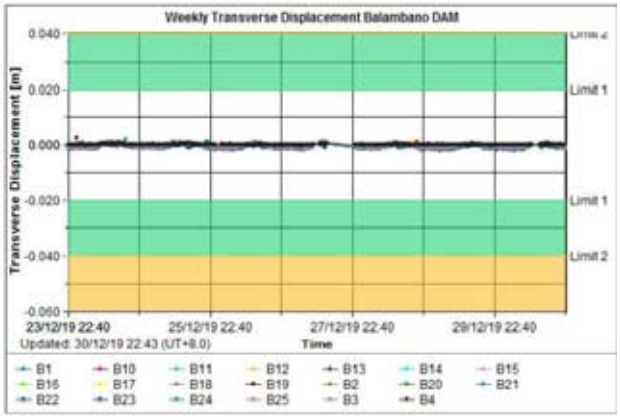

Figure 14 : Balambano Robotic crest movement transverse graph

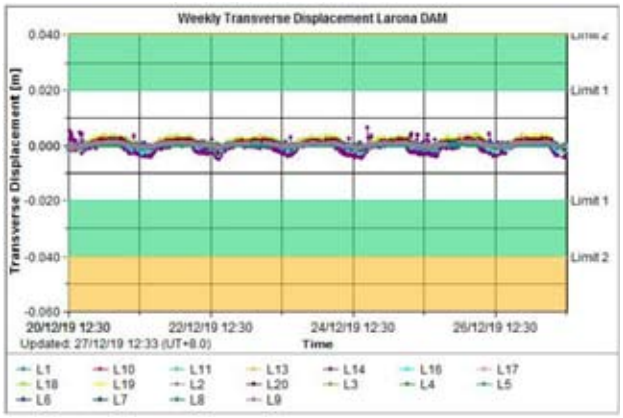

Figure 15 : Larona Robotic crest movement transverse graph

4. CONCLUSIONS

Dam safety is aimed at protecting the dam from the failure of the dam and protecting the soul, property, and public infrastructures that reside in areas affected by the potential danger due to dam failure. In order to minimize the risk of dam failure, intensive monitoring is required, and anywhere through data and visualization and real time. From the result we can see the data and visual information obtained in the condition of real time, and comprehensive (complete), can be accounted for scientifically also with testing conducted manual measurement.

Suggestions Dam security through intensive monitoring, and anywhere through data as well as visualization and real time continuously with the Telemetry-based Website is a very effective tip to be applied to every dam across Indonesia.

REFERENCES

Pratama, A. 2018. Instalation dam monitoring systems Karebbe dam, Leica Geosystems. Indonesia.