An Evaluation of the Success Rate of Sermo Dam Management in Daerah Istimewa Yogyakarta

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Abstract. In dam operating and maintaining activities, there are some activities becoming the main function: the assessment of dam condition to keep monitoring and safeguarding the condition of dam as the main building. To achieve the maximum service, the maximal dam management is required as well and it should be followed with management evaluation. This case study was taken place in Sermo Dam of Daerah Istimewa Yogyakarta during 2015-2017. The method applied in this study was descriptive quantitative one, conducting a research using primary and secondary data. In this research, the assessment of dam condition was viewed from 1 (one) component, dam body, so that the component weight was 100%. The value of dam body condition was obtained from data of Sermo Dam monitoring in 2015-2016 and from the result of field survey in 2017. The result of research showed that the condition values of Sermo Dam with dam body component were 92.66% in 2015, 92.99% in 2016, and 93.99% in 2017. The result also showed that the value of dam body condition tended to increase during 2015-2017. To maintain the condition, the maximal operation and maintenance of dam was recommended.

1. Introduction
The news of Situ Gintung (Gintung Lake) collapsed on March 27, 2009 at 04.30 Local Time with more than 100 life tolls has stricken all of us. Because of its low dam embankment, in addition to having large benefit, it stored a great destruction power. The incidence of Situ Gintung breakage was a failure in Dam Operating and Maintaining activities. In Dam operating and Maintaining activities, there are some activities becoming the main function: the assessment of dam condition to keep monitoring and safeguarding the condition of dam as the main building. Sermo dam (Waduk Sermo) has been beginning to operate since October 1996, with (gross) load of 25 millions m³ at +136.6 m elevation (maximum normal water surface elevation) consisting of 21.9 millions m³ as water load volume, 3.1 millions m³ as dead storage volume, and dam puddle width of 1.57 km². The reservoir’s catchment area width is 21.47 km². A big inspection has been conducted in 1996, 2004, and 2015, and Dam Monitoring Report is made annually. Dam management should be evaluated by considering the condition value of dam over years. This research is intended to find out whether or not the dam management tends to provide increasing, common or decreasing condition value in 2015-2017.
2. Methodology
The objective of dam management is to prevent the risk resulting from dam damage (Herlen, 2009). The management of PB. SOEDIRMAN, according to Public Work Minister’s Regulation No. 72/PRT/1997, is to conduct geotechnic monitoring, dam instrumentation monitoring, survey monitoring, hydrology and climatology monitoring, dam sedimentation monitoring, and environment and water quality monitoring. Marzulian Ramli and Bambang E. Yuwono, (2015) in their study also suggested that to minimize the failure of dam operation, there should be a maximal management. Yulius Heryant, et al (2014) stated that in operating and maintaining dam, there should be an assessment on dam as included in the Guidelines of Physical Dam Condition Assessment referring to the Government Regulation Number 37 of 2010 about Dam.

2.1 The Assessment of Dam Condition
The Guidelines of Physical Dam and Reservoir Condition Assessment issued or published by Balai Bendungan (Dam House) in 2010 governs the procedure of assessing Dam and its Reservoir. In maintaining dam correctly and well, there should be an assessment on dam as included in the Guidelines of Physical Dam Condition Assessment referring to the Government Regulation Number 37 of 2010 about Dam. The assessment on the physical condition of dam and its reservoir is conducted in some components: 1) Reservoir including: a) sedimentation, b) Reservoir’s watershed area, c) Green Belt Area, and d) Reservoir’s inflow; 2) Dam body, including: a) downstream slope, b) dam peak, c) upstream slope, d) supporting area, and e) leakage; 3) Complementary Building, including: a) withdrawal building, d) release building, and c) transferring building, and 4) complementary building, including: a) withdrawal building, b) release building, and c) transferring building. The weighing of each component and sub component in the assessment of dam’s physical condition becomes the reference in estimating the damage index of dam’s each component and sub component. The component and weight of assessment in every dam as well as its reservoir according to Standard Guidelines of Dam’s Physical Condition Assessment of 2010 as follows:

![Diagram of Dam Condition Assessment](image)

- Sedimentation (3%)
- Green Belt Area (3%)
- Inflow (4%)
- Upstream Slope (10%)
- Peak (10%)
- Downstream Slope (10%)
- Stepping Plane (5%)
- Leakage (5%)
- Withdrawing Building (10%)
- Releasing Building (10%)
- Flowing Building (20%)
- Leakage Gauge (3%)
- Pore Pressure Gauge (3%)
- Movement Gauge (3%)
- Observed Well (1%)
Figure 1. The scheme of component and weighing for the Assessment of Dam and Reservoir Physical Condition (Anonym, 2010).

The classification of condition assessment is made based on problem and damage level (severity level) of dam and reservoir. The classification of condition assessment can be seen in Table 1.

Table 1. Value of Dam Component Condition.

| No. | Condition         | Notes                                                                 |
|-----|-------------------|----------------------------------------------------------------------|
|     | Good              | If the condition value >90% and severity level <10% of the prior condition of building. |
|     | Mildly damaged    | If the condition value 80-90% and severity level 10-20% of the prior condition of building |
|     | Moderately damaged| If the condition value 60-70% and severity level 21-40% of the prior condition of building |
|     | Severely damaged  | If the condition value <60% and severity level >40% of the prior condition of building |

Source: Balai Bendungan (Anonym, 2010)

Figure 2. Research Location in Sermo Dam.

The first measure taken in this research was to collect secondary data in the form of data of Sermo Dam monitoring during 2015-2016 and data of big inspection on Sermo Dam in 2015 obtained from BWS Serayu Opak and primary data through field survey to obtain the condition value of Sermo Dam in 2017. Referred to the Guidelines of Physical Dam Condition Assessment referring to the Government Regulation Number 37 of 2010 about Dam, this research assessed the condition value of Dam viewed from 1 (one) component, dam body, so that the component weight become 100%. Subcomponents of dam body include downstream slope, dam peak, upstream slope, supporting area, and leakage. So that it can be illustrated in the scheme below.

Figure 3. Scheme of component and weighing for the Assessment of Dam and Reservoir Physical Condition in Dam Body (Anonym, 2010).
3. Analysis and Discussion

3.1. The assessment on Dam Body in Sermo Dam in 2015

The assessment on Dam Body in Sermo Dam in 2015 used monitoring data of Sermo Dam in 2015 and big inspection data of Waduk Sermo in 2015.

3.1.1. Upstream Slope.

![Figure 4](image)

Figure 4. Condition of Sermo Dam Upstream Slope in 2015.

The slope protector consists of rip-rap (empty stone), apparently regular/stable slope inclination, no sign of movement found, no erosion and ruin flow found, weathering began to appear, wild plant including short grasses only, no subsidence found, and no animal hole or nest found. Watershed is not straight as the organization of replacing new rip-rap stone with old stone, the stone detached due to the fishermen’s action. No water rotation existed along the watershed. This condition value of upstream slope obtains score of 94 (good).

3.1.2. Dam Peak.

![Figure 5](image)

Figure 5. Condition of Sermo Dam’s Peak in 2015.

The surface width of 8.00 m, asphalt hardening (hotmix), surface crack, (hair crack) on the right, the decrease (vertical movement) can be seen on the right side starting from Sta.15 to the right, the good/smooth straightness (horizontal movement), there is a safeguard fence (good condition) but there were some bolts vanishing in some parts. This condition value of dam peak obtains score of 91 (good).

3.1.3. Downstream Slope.

![Figure 6](image)

Figure 6. The condition of Sermo Dam Downstream Slope in 2015.
Generally, its condition is as same as that of downstream slope; the protector of slope consists rip-rap (empty stone), apparently regular/stable slope inclination, no sign of movement found, no erosion and ruin flow found, weathering began to appear, wild plant including short grasses only, no subsidence found, no animal hole or nest found, no new leakage and wet area. The value of downstream slope condition obtains score of 93 (good).

3.2. The assessment of Dam Body Condition in Sermo Dam in 2016

3.2.1. Downstream Slope.

![Figure 7](image1.png)

**Figure 7.** The condition of Sermo Dam Upstream Slope in 2016.

The condition of upstream slope was good, with the planned ratio of 1:1.8. The protector of slope includes rip-rap, there was a sign of uneven slope inclination condition due to weathering, there was no erosion, the plant was weeded once in a month, the decrease on the left and the right, no ruins, and no animal nest were found. There is a decrease of protecting layer stone in upstream part of dam peak in Sta.15 with the decrease of ± 30 cm. The value of upstream slope condition obtains score of 92 (good).

3.2.2 Dam Peak

![Figure 8](image2.png)

**Figure 8.** Condition of Sermo Dam Peak in 2016.

The surface width is 8.00 m, length is190 m, asphalt hardening (hotmix); there was no surface crack, there was no deflection, the straightness consistent with the plan. There is usually no exterior condition. The value of this dam peak condition obtains score of 94 (good).

3.2.3 Downstream Slope.

![Figure 9](image3.png)

**Figure 9.** The condition of Sermo Dam Downstream Slope in 5.
The planned inclination condition is 1: 1.7; generally the condition is as same as that of upstream slope, the protector of slope consists of rip-rap (empty stone), apparently irregular/unstable slope inclination condition, no sign of movement, erosion flow and ruins found, no weathering apparent, wild plant including short grasses only, no subsidence found, no animal hole or nest found, no new leakage and wet area found. The value of upstream slope condition obtains the score of 93 (good).

3.3. The assessment of Dam Body in Sermo Dam in 2017

The assessment of Dam Body in Sermo Dam in 2017 was conducted using primary data, the data obtained from field survey in 2017.

3.3.1 Upstream Slope

![Figure 10. Condition of Sermo Dam Upstream Slope in 2017.](image)

Considering the result of survey on dam body, it could be found that the condition was good, the slope protector consists of rip-rap (empty stone), regular or unstable inclination condition. There is usually no exterior condition. The value of upstream slope condition obtains the score of 93 (good).

3.3.2 Dam Peak

![Figure 11. Condition of Sermo Dam Peak in 2017.](image)

The condition of dam peak seems to be good, no surface crack was found, no deflection was found, no decrease was found, and the straightness was as planned. There is usually no exterior condition. The value of upstream slope condition obtained the score of 94 (good).

3.3.3 Upstream Slope

![Figure 10. Condition of Sermo Dam Upstream Slope in 2017.](image)
Generally, the condition is still good, the protector of slope consists of rip-rap (empty stone), apparently irregular/unstable slope inclination condition, no sign of movement, erosion flow and ruins found, weathering beginning to appear, wild plant including short grasses only, no subsidence found, no animal hole or nest found, no new leakage and wet area found. The score of embankment slope is 95 (good).

Having obtained the assessment on each sub component of Sermo Dam, the assessment is accumulated in each sub component of Sermo Dam, and the condition of Sermo Dam in 2015, 2016, and 2017 is obtained, as shown in table 2.

Table 2. Condition Value of Dam Body in 2015-2017.

| Subcomponent of Dam | Condition Value of Dam Body in 2015-2017 |
|---------------------|------------------------------------------|
|                     | 2015 | 2016 | 2017 |
| Upstream Level      | 31.33 | 30.66 | 31.00 |
| Dam Peak            | 30.33 | 31.33 | 31.33 |
| Downstream Slope    | 31.00 | 31.00 | 31.66 |
| Total               | 92.66 | 92.99 | 93.99 |

![Condition Value of Dam Body in 2015-2017](image)

Figure 13. Chart of Sermo Dam Downstream Slope Condition in 2017.

The result of assessment on Sermo Dam condition with the dam body component obtain scores of 92.66% in 2015, 92.99% in 2016 and 93.99% in 2017, indicating that Sermo Dam condition is good (condition value >90%-100% and severity level <10%), viewed from the component of dam body in 2015-2017. From the value, it can be seen the trend of Sermo Dam condition value with dam body component. The trend increases over times despite insignificance.

4. Conclusion

From the discussion above, the following conclusion could be drawn:

1. The result of research showed that the condition value of Sermo Dam with dam body component were 91.33% in 2015, 91.66% in 2016, and 93.99% in 2017.
2. The result also showed that the value of dam body condition tended to increase during 2015-2017. To maintain the condition, the maximal operation and maintenance of dam was recommended.
5. **References**

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