Assessment of Swa Dam Breach Using Empirical Formulas and Satellite Data

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1. Introduction

Though dams provide various benefits for livelihood, their failures also would deliver adverse effects to localities in downstream. Myanmar, a country in Southeast Asia with an area of 615,678 km^2 and 52 million populations, have already experienced several dam failures cases which leads to the need of investigation of the dam breach and its consequences of inundation in the downstream area and share such information with the stakeholders living in the downstream areas so that preventive measures can be put in place to avert catastrophic damages. For example, the spillway collapsed event of Swa Dam in Myanmar was happened recently in 2018, impacted a number of damaged to downstream societies. However, case studies of dam breach event in Myanmar is still limited. Although there are several previous studies that have proposed disaster risk assessments for dam failures (e.g., Froehlich, 2008), its effectiveness has not been fully verified for dam failure cases in Myanmar.

The objective of the study is to assess the dam breach event happened in Swa dam in order to analyze the characteristics of the spillway breach, breach mechanisms and consequences on downstream using simple approach such as empirical equations proposed by previous studies.

2. Material and Methods

2.1 Study area

Swa dam is located within Yedashe Township in Bago Region, southern part of Myanmar (Map reference 94A/4 V645250) (Fig. 1). Location has average annual rainfall of 2127 mm which gives average annual inflow 385 million m^3. The dam was constructed in 1999 and completed in 2005. It is an earthen typed dam which has a catchment area of 1044 km^2. Dam height is 29.57 m and it is 2011.68 m in length. The dam has a total water volume of 267 million cupid meter in its fully storage. The reservoir area is 2792 ha and irrigation scheme is 14,164 ha. Spillway type is Reinforced Concrete Bath tube (duckbill) which has 122 m crest length, 170.7 m long and spillway discharge is 1486 m^3/s.

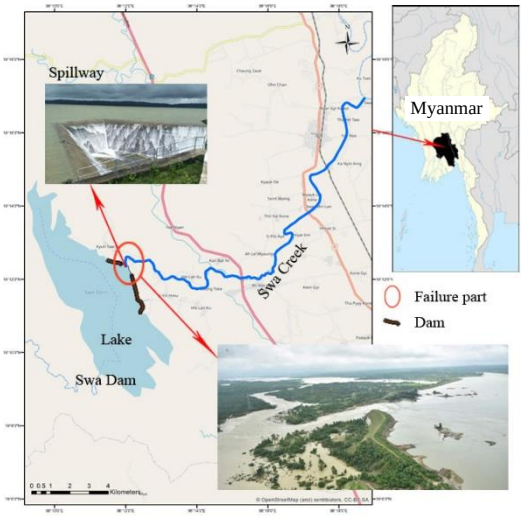

Figure 1. Location of study area

2.2 Data

Swa spillway collapsed at about 5:30 am in the morning of 29th August 2018. Spillway was overflowed about 0.5 m water depth above the crest and water level was about 102.68 m which was about 4.1 m to the crest of the dam embankment. Water levels during the event were recorded for two days by Irrigation and Water Utilization Management Department (IWUMD) of Myanmar. Field survey was conducted after the flood and elevation contour map of study site after the breach was also prepared by IWUMD. After the failure event, technical teams by IWUMD investigated the spillway collapse site to find the causes of the collapse and the factors that could effect on the stability of spillway.

3. Results

3.1 Topographic change

From the topographic data, the maximum cross sectional width of the breach is about 148.73 m, bottom width of breach is about 71.93 m and average breach width is 110.33 m. Height of Breach is about 26.28 m from the dam crest RL- 107.28 m, as shown in Figure 2.

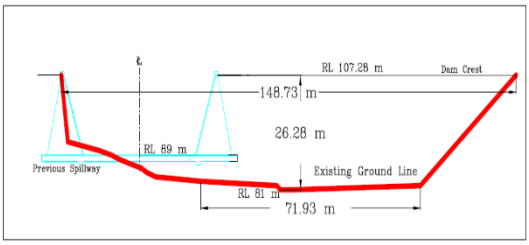

Figure 2. Cross section of breach (Blue before, Red after)

3.2 Outflow Hydrograph

Maximum breach discharge occurred in spillway failure event was calculated which was about 7218.5 m^3/s at 102.68 m water level happened at 5:30 am in the morning using observed water level recorded during the breach and height-volume relationship of the Swa dam as shown in Figure 3.

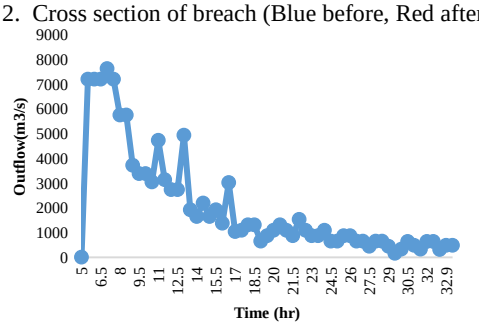

Figure 3. Calculated Breach outflow

4. Discussions & Conclusions

In this study, observed breach parameters and peak discharge of Swa dam were compared with calculated parameters by using empirical formulas from previous research. The most common empirical equations were selected into consideration as shown in Table 1. It is found that the calculated results from MacDonald's breach equations provided the highest values whereas the Bureau of reclamation gave the lowest values in terms of average breach width, and peak outflow respectively. Froehlich's predictor equations provided the nearest values in average breach width while, Pierce's method could explain data in Swa dam for peak discharge.

From these results, it was confirmed that dam breach parameters and peak outflow of Swa dam case could be predicted if we can select an appropriable empirical formula. On the other hand, sufficient accuracy may not be obtained if an incorrect formula was selected such that peak flow rate may be underestimated several times. In the future, we would like to consider the reason for the low accuracy and how to select a suitable formula for dams in Myanmar.

Table 1. Comparison of calculated and observed breach parameters & outflow for Swa Dam

	MacDonald et al (1984)	Bureau of Reclamation (1988)	Soliman (2015)	Froehlich (1995a)	Froehlich (2008)	Pierce (2010)	Swa Dam
Breach average width (m)	349	67	168	169	155	-	110.33
Breaching time T_f (hr)	2.62	0.73	2.28	4.01	3.56	-	2.5
Peak Outflow Q_p (m^3/s)	12489.72	5913	-	8793.53	-	8269.15	7218.5

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