Dam Break Analysis of Pawana Dam

[1]S. R. Kulkarni, [2]Seema A. Jagtap

[1]Civil Engineering Department, Yadavrao Tasgaonkar College of Engineering & Management University of Mumbai, Maharashtra, India

[2](I/C/)Head of Civil Department, Thakur College of Engineering & Technology, Mumbai, Maharashtra, India

Abstract – This paper illustrate the study of dam break analysis of Pawana dam using HEC-RAS software. The mentioned analysis is very helpful in estimation of flood after dam break. Also, to know the number of villages affected due to dam failure with rehabilitation cost. Further to know the submergence area and the flood lines. Some more advantages of dam break analyses which are very important from view point of planning on downstream side of the dam for assessment of emergency action plan commonly known as EAP.

Keywords: Dam-Break Analysis, Dam Breach, Pawana dam, HEC-RAS

I. INTRODUCTION

A. Dam Break Analysis:-

Characterization and identifying of potential dam failures are post effects of resulting floods from dam breach. It is this characterization of the threat to public safety that a dam poses decides the categorization of the dam and also the standard of care, safety and maintenance to which the dam is believed. Inflow Design Flood (IDF) is one among the various design parameters which forms the basis for spillway design. The necessity to develop an emergency action plan, requires preparation of inundation maps which accurately envisage arrival times at critical locations and dam breach flood depths. The population alongside associated critical sections are located in vicinity of dam downstream, details of the breaching process and the calculated peak discharge might have effect on the results. In this case, the predominant parameters are the attenuation, travel time and other routing effects. The breach parameters like breach width, depth, and rate of development are more crucial to analysis especially when the residents are living near to the dam. the inaccurate prediction of breach parameters resulting in increased associated cost and assumptions. Colorado dam safety engineers Jeremy Franz, John G. Blairin association with some others prepared guidelines under the direct supervision of Mark Haynes, Chief, Colorado Safety of Dams Program.

a. Need for Dam-Break Analysis:-

Two major consequences of a dam failure are:-

1. Life loss: Because of heavy flood resulting from dam-break this loss may occurs if the villages and the residing families are washed away.

2. Economic: This loss is calculated in terms of revenue which will be required to rebuild the washed away villages in terms of infrastructure, and other allied facilities. The dam break analysis will make possible to predict the flood and areas affected by flood at downstream due to breach. This helps in estimation of cost in case of rehabilitation. The study predicts the potential of precautionary measures which can be taken to completely avoid the dam break which avoid or minimize damage.

II. METHODOLOGY

In dam-breach analysis of Pawana dam, Empirical method is used to envisage time to failure and breach geometry, as well as to predict peak breach discharges. In this study, the empirical equation i.e. Froehlich empirical equation 2008. [i] have been used to estimate the dam breach flood. The Froehlich empirical equation 2008. [i] Empirical approach depends on statistical analysis of obtained data for failures. A study on assessment of flood using Empirical methods was performed. As above mentioned Guidelines are the recommended empirical tools for predicting dam breach parameters within the State of Colorado. In calculation of breach parameters, all dimensions in Fig. No. 1 are in Ft., for calculating Bavg, wherever necessary the values are converted to British units and same are converted into SI system for modeling purpose) Breach parameters are as follows:

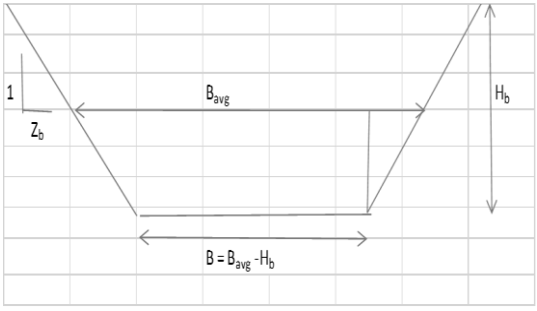

Figure 1: Sketch of Breach

Table 1 Breach parameters and discharge:-

Breach	K_o	V_W in Acre-Ft	H_b in Ft	H_w in Ft	B_{avg} in Ft.
Breach-1	1.3	247268	32.8	23.124	655.03

Table 2 Breach parameters and discharge

Breach	B_{avg} in Mt.	T_f in Hr.	A_s in Acres	ϒ	Q in cfs
Breach-1	199.7	9.788	527	188.4	1156

HEC-RAS:-

HEC-RAS is developed by Hydrologic Engineering Centre (HEC), which is the division of Corps of Water Resources (IWR), US Army Corps of Engineering. The software was designed by Mr. Gary W Brunner, leader of HEC-RAS development team. The software is based on standard step method considering 25 and 100 years peak flow and knowing water level and total energy at particular river station, water level at any river station is actually calculated. The first version of HEC-RAS (Version 1.0) was released in July, 1995. Subsequently there are several major releases of this software package, including version such as 1.1 ; 1.2 ; 2.0 ; 2.1 ; 2.2 ; 3.0 ; 3.1 ; 4.0 and now version 4.1 in January, 2010..

The survey sheet available from the Survey of India, Pune is used for calculating contour and distances for cross section along downstream of the river Pawana.

The parameters derived from the Froehlich empirical equation 2008 and contour levels, distances for all sections along downstream side of the river are used in HEC-RAS software to model for the analysis of the river Pawana.

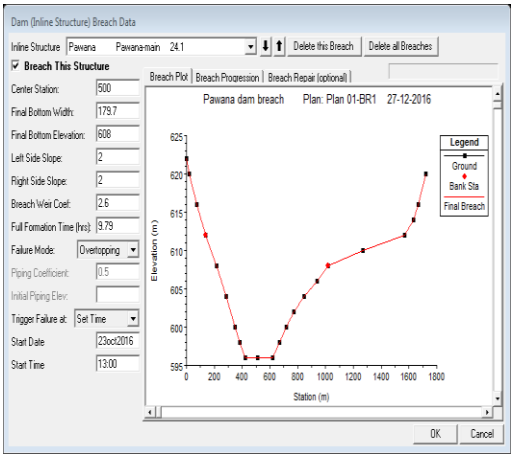

Figure 2: Window of HEC-RAS

The results obtained from HEC-RAS model at downstream for Maximum discharge, velocity. Elevation and top width are as tabulated below:-

Table 3 Showing maximum discharge, velocity, elevation & top width

Location at Km.	Maximum Discharge in m^3/s	Maximum Velocity in m/s	Elev. in Mt.	Top Width in Mt.
04.00	30324.60	3.27	592.	1929.00
09.00	17954.02	4.54	585.	1144.57
14.00	9366.78	2.05	582.	1101.24
19.00	5019.05	2.93	579.	738.67
23.00	2546.25	1.87	576.	578.40

The hydrograph obtained from HEC-RAS model at 4.0 Km at downstream side of the river Pawana are below:- From comparing the reduced level of the villages at downstream with the result table, it is observed that, if any disaster happens then the following villages will be affected by the flood due to dam break. It was observed that, villages such as Bramnoli, Bhadaval, Kadhade, Thugaon, Baur, Malavandi, Shivane, Pimpal khunte, Bebed ohal, Paranwadi, Damne are in proximity of the flood of the pavna dam in case of disaster i.e. dam break.The population data of the above villages are taken fron the internet and the number of families are calculated by considering 5 persons /one family.

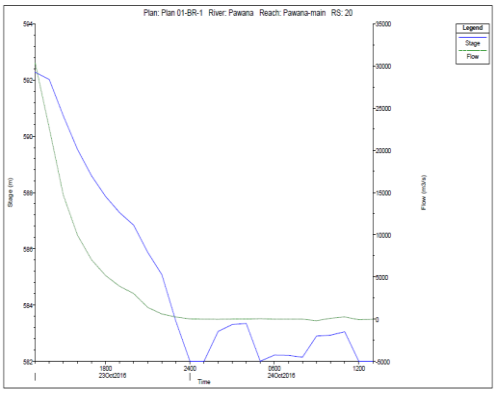

Figure 3 Hydrograph at 4.0 Km

Table 4 Rehabilitation cost of villages

Name of the Village	Human Population (Approx)	No. of Famalies (Approx.)	Rehabilitation cost (in lacs)
Bramnoli	618	124	1,860
Bhadaval	427	86	1,290
Kadhade	1500	300	4,500
Thugaon	982	197	2,955
Baur	1207	242	3,630
Malavandi	930	186	2,790
Shivane	2067	414	6,210
Pimpal khunte	715	143	2,145
Bebed ohal	2928	586	8,790
Parandwadi	2317	464	6,960
Damne	1982	397	5,955

Thus, the total cost for rehabilitation of the villages is estimated to be 470.85 crore. This has been calculated by considering 15 lac per family. It includes land cost, construction cost, and infrastructure cost.

Remedy i.e. emergency action plan proposal:-

The above rehabilitation cost associated with this analysis may not affordable to the society. The Dam Break can be avoided if proper maintenance and safety measures are taken into consideration.

In case of disastar safety measures and maintance,the following mersures are to be taken:-

1) Step by step instructions for operating all mechanisms associated with the dam
2) Operation of the lake, including the inflow and outlet devices
3) Release rate instructions and schedules for maintaining any required downstream flows
4) Safety and security measures deployed at the site
5) Remove all underbrush and trees from the dam and establish a good grass cover.
6) Fill animal burrows.
7) Repair livestock trails and fences to keep livestock off dam.
8) Restore and reseed eroded areas and gullies on embankment dams.
9) Repair defective spillways, gates, valves, and other appurtenant features.
10) Repair any concrete or metal parts that have deteriorated.
11) Routine mowing and general maintenance.
12) Maintenance and filling of any cracks and joints on concrete dams and in concrete spillways.
13) Observation of any springs or areas of seepage, comparing quantity and quality (clarity) with prior observations.
14) Routine technical inspection of the dam.
15) Maintaining & Repairing Gutters
16) Maintaining & Repairing Dam Slopes with Riprap
17) Maintaining a logbook in which activities (such as maintenance and inspections) are recorded
18) The following warning methods and achieving the necessary action was assessed:

- public warning signals (sirens)
- emergency bulletin on the radio
- loudspeaker vehicles of rescue units
- telephone and mobile phone (group calls)
- warning people indoors from house to house.

19) Evacuation centres:- The social and health services organize such centres and several voluntary rescue service personals are used.

In addtion to above,

1) Monitoring of development in the watershed that would materially increase runoff in downstream.
2) Monitoring of development downstream and updating the emergency notification plan to include new houses or other occupied structures within the area.
3) Auxiliary (Emergency) Spillways

III. CONCLUSION

The dam break analysis of Pawana dam has been done with the help of empirical equation and by using HEC-RAS software. The maximum discharge, velocity, elevation and top width is obtained to find out the number of villages are going to affected at the downstream of the Pawana river. It is easy to estimate the flood and flood routing. It is very difficult to estimate the cost of maintenance and safety precautions for the given dam. The estimated total cost of rehabilitation of villages is Rs. 470.85 crore. The cost incurred in rehabilation is much more than which is much more than the dam maintenance cost. Thus it can be said that precaution is better than cure.

VI. ACKNOWLEDGEMENT

I hereby take opportunity to give my sincere thanks to Dr. S. K. Ukarande and Prof. Seema A. Jagtap for their guidance and constant encouragement and support in this paper. I truly appreciate the value and their esteemed guidance and encouragement which would be remembered lifelong.

REFERENCES

[1] Office of the state engineer dam safety branch, February 10, 2010, guidelines for dam breach analysis, state of colorado department of natural resources division of water resources

[2] The Regulation published in the Gazette of Dam Safety Act and Regulation Government of Quebec, Canada Photograph from Google.

[3] MacDonald, T.C., and Langridge-Monopolis. 1984, Breaching Characteristics of Dam Failures, Journal of Hydraulic Engineering, Vol. 110, No. 5,, pp. 567-586

[4] Von Thun, J.L., and Gillette, A.M., (1990). Guidance on Breach Parameters, Unpublished internal document, U.S. Bureau of Reclamation, Denver, CO, March 13, 1990

[5] Wetmore, J. N. and Fread, D. L. (1984). The NWS Simplified Dam Break Flood Forecasting Model for Desk-top and Hand-held Microcomputers. Federal Emergency Management Agency. 1984.

[6] Froehlich, D. C. 1995a, Peak Outflow from Breached Embankment Dam, Journal of Water Resources Planning and Management, pp. 90-97.

[7] Froehlich, D. C. San Antonio, Texas: s.n., 1995b, Embankment Dam Breach Parameters Revisited, Water Resources Engineering, Proceedings of the 1995 Conference on Water Resources Engineering. pp. 887-891

[9] Estimation of Consequences, federal energy regulatory commission office of energy projects division of dam safety and inspections