Published by :
http://www.ijert.org
International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

Cheruthoni Dam Break Analysis

Sajna K Anas
Student, Department of Physics
Catholicate College Pathanamthitta
Mahatma Gandhi University

Ruben A Varughese
Student, Department of Physics
Catholicate College Pathanamthitta
Mahatma Gandhi University

***Abstract*— This study is aimed to evaluate the wave which forms when water from the Mullaperiyar hits the water column of the Idukki reservoir that could overtop the Cheruthoni Dam Kerala, India. This dam was constructed in the year 1976. It is important to examine the effect of water that rushes into it at the time of emergency. The present study includes the dam break flood analysis of the Mullaperiyar dam up to the Idukki reservoir. This project is an extension to it.**

Dam break failures are often caused by overtopping of the dam due to inadequate spillway capacity during large inflows into the reservoir from heavy rainfall-generated runoff. Dam failure may also be caused by seepage or piping through the dam or along internal conduits, earthquake and landslide generated waves in the reservoir. For a cascade of dams, the breaking of one dam may cause subsequent damage to other dams located downstream due to their overtopping.

Partial or catastrophic failure of a dam leading to uncontrolled release of water cause severe damages to lives and properties of people situated downstream. The effect of such a flood disaster can be mitigated to a great extent, if the resultant magnitude of flood peak and its time of arrival at different locations downstream of the dam can be estimated, facilitate the planning of emergency action measures. The most suitable instruments for analysis and prediction of a dam break flood are mathematical hydrodynamic simulation models. These models can be used for prediction of dam breach flood hydrograph and its routing through downstream valley to obtain the time series of discharge and water level at different locations of the valley. The present study includes the dam break flood analysis of the Mullaperiyar dam up to the Idukki reservoir.

***Keywords*— Arch-gravity dams**

INTRODUCTION

This study is aimed to evaluate the wave which forms when water from the Mullaperiyar hits the water column of the Idukki reservoir that could overtop the Cheruthoni Dam Kerala, India. This dam was constructed in the year 1976. It is important to examine the effect of water that rushes into it at the time of emergency. The present study includes the dam break flood analysis of the Mullaperiyar dam up to the Idukki reservoir. This project is an extension to it.

Dam break failures are often caused by overtopping of the dam due to inadequate spillway capacity during large inflows into the reservoir from heavy rainfall-generated runoff. Dam failure may also be caused by seepage or piping through the dam or along internal conduits, earthquake and landslide generated waves in the reservoir. For a cascade of dams, the breaking of one dam may cause subsequent damage to other dams located downstream due to their overtopping.

Partial or catastrophic failure of a dam leading to uncontrolled release of water cause severe damages to lives and properties of people situated downstream. The effect of such a flood disaster can be mitigated to a great extent, if the resultant magnitude of flood peak and its time of arrival at different locations downstream of the dam can be estimated, facilitate the planning of emergency action measures. The most suitable instruments for analysis and prediction of a dam break flood are mathematical hydrodynamic simulation models. These models can be used for prediction of dam breach flood hydrograph and its routing through downstream valley to obtain the time series of discharge and water level at different locations of the valley. The present study includes the dam break flood analysis of the Mullaperiyar dam up to the Idukki reservoir.

THEORY

Dams are hydraulic structures of fairly impervious material built across a river to create a reservoir on its upstream side for impounding water for various purposes. These purposes may be Irrigation, Hydropower, Water-supply, Flood Control, Navigation, Fishing and Recreation. Dams may be built to meet the one of the above purposes or they may be constructed fulfilling more than one. As such, Dam can be classified as: Single-purpose and Multipurpose Dam. “The bigger the dam of patience, the worse will be the flood when it breaks.”

A gravity dam can be combined with an arch dam into an arch-gravity dam for areas with massive amounts of water flow but less material available for a purely gravity dam. The inward compression of the dam by the water reduces the lateral (horizontal) force acting on the dam. Thus, the gravitation force required by the dam is lessened, i.e. the dam does not need to be so massive. This enables thinner dams and saves resources.

a. 1.2 Required Measurements

There are a few measurements that you need to know

- Surface area
- Maximum depth

SURFACE AREA:

- The surface area of a dam is calculated by multiplying the length by the width. Example: 30 metres X 50 metres = 1500 m^2.
- This will be the case for square or rectangular dams. Most dams start out as a square or rectangle, but over time appear to become rounded. If the dam is not exactly square, round the measurements off.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

VOLUME:

- With the surface area depth calculated, the volume can then be determined: Volume (m^3) = Surface Area (m^2) x Max depth (m) x 0.4 (Where 0.4 accounts for the batter slope on the sides of the dam)

DEPTH:

- One way to determine dam depth is to row out into the dam and lower a weighted line over the side. When the line is vertical, measure the length of the line needed to reach the bottom. Alternatively, use a pole with distances marked on it. You will need to do this at a number of places across the dam to find the deepest point.
- The distance between the float and the sinker will be the depth at that point in the dam.

Sample paragraph, The entire document should be in cambria font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes. The entire document should be in cambria font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes.

2. WORK

This work mainly concentrates towards the event that, if Mullaperiyar Dam which is situated at Tamilnadu-Kerala boarder fails at its full capacity during a monsoon season, water rushes towards the Idukki reservoir catchment area through the Periyar river after travelling a distance of approximately 83.3kms by taking about 2hrs 8m[1].Considering both Idukki and Mullaperiyar at their full capacity, a calculation is done to examine about the wave which forms when the water from the Mullaperiyar hits the water column of the Idukki reservoir could overtop the Cheruthoni Dam[2].

Dams are designed to hold the maximum amount of water at its worst conditions of earthquakes, silt sedimentation, sudden increase of water pressure during monsoon season etc. But the study of the wave which forms by the hitting of the water column from Mullaperiyar were not specified by any Authorities.

For this, we are considering a volcanic explosion which takes place in the deep sea creating large waves. Studies have found that it can form circular Tsunami waves of width 1km approaches toward the shore, but since the wave have to travel a large distance from the point of impact, the circular shape of the wave front can be changed to a plane one, which will have a shape of a cuboid[3]. Thus, the volume of the whole column can be calculated using the formula of

$v = lbh$

Where,

v-volume of column.

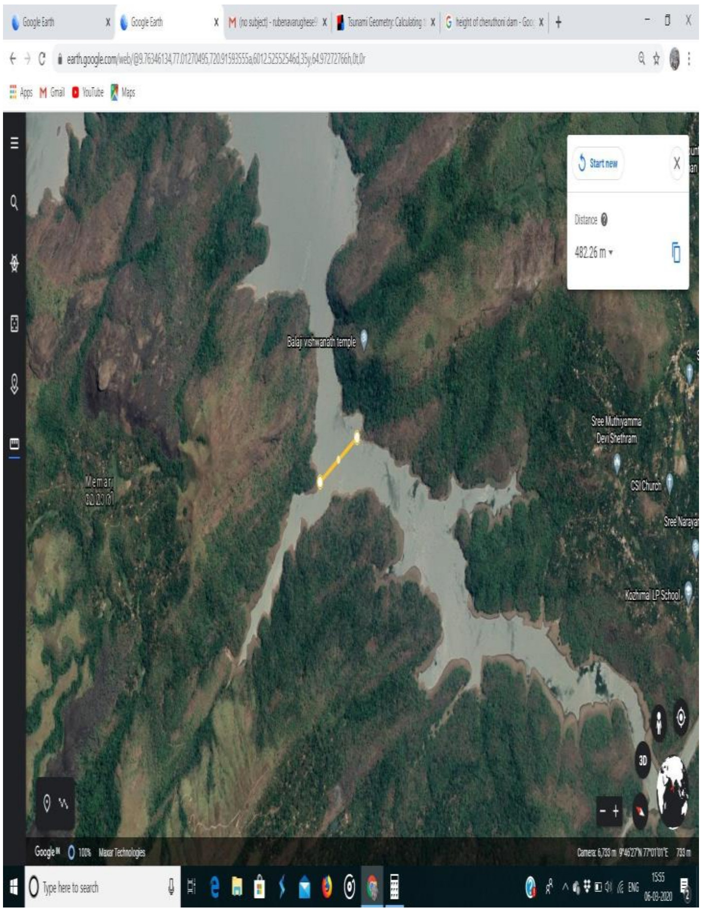
l-length of the column.

b-width of the column.

h-height of the column.

Now on pointing towards the Idukki reservoir, we are considering two regions of the water body. One is the point at which the Periyar river joins the reservoir where the water from the Mullaperiyar rushes and hits the water in the Idukki Dams to form large waves which have chances to hit directly towards the Cheruthoni dam. Second is a point near the Cheruthoni dam where the path is narrower than the first point. So, the intention of this work is that the change in length of the two regions, keeping the width of the wave as a constant can lead to the increase in its height. Thus, a wave of height larger than the wave formed at the impact point will hit on the dam by considering the attenuation as negligible.

***REGION 1:**



The region given in the above figure is the impact point of the water from Mullaperiyar Dam on the Idukki Reservoir. The volume of the water column is given by

$v = lbh$

l=482.6m

b =1km=1000m h =14m (std. height of a wave)

$v = 482.6×1000×14$

$=67,51,640 litres.$ ... (1)

***REGION 2:**

The region given in the above figure is a narrow region which is directed towards the Cheruthoni Dam. The volume of the water column at this point is to be determined, but the available data are not sufficient in order to calculate it. The volume of the water column at this point is given by

$V = LBH$ At this point,

L =447.43m

B =1000m

H =?

$$V = 447.43 \times 1000 \times H. \qquad ..(2)$$

*Since, the wave is propagated throughout the water body, the volume is assumed to be same at each point on the surface of the water body. Thus, the volume we have got in **REGION 1** and **REGION 2** can be considered as equal. Thus,

$lbh = LBH$

From (1) and (2)

$$447.43 \times 1000 \times H = 67{,}51{,}640 \; litres \qquad ..(3)$$

From (3)

$$H = 15.08m. \qquad ..(4)$$

* Therefore, the change in height, when the wave passes through the **REGION 2** can be given by

$$\Delta h = H - h = 15.08 - 14 = 1.08m.$$

For the water to overtop the dam, the height of the water column must be higher than the height of the dam. At the extreme condition, the water will be at its maximum permitted level called the Maximum Water Level (MWL). The calculated height of the wave formed near the dam is 15.08m. Thus, the height of the wave at the hitting point will be the sum of Maximum Water Level and the height of the wave formed.

The Maximum Water Level (MWL) = 2409ft = 734.26m.

The height of the dam structure = 2415ft = 736.09m (from sea level).

The height of wave at hitting point on dam = MWL+ H =734.26 + 15.08 = 749.34m.

Height of the wave compared to the dam = 749.34 – 736.09 = 13.25m.

From the calculation, it is found that the height of the wave formed is higher than the height of the dam structure i.e., the difference of the height of the wave with the dam structure is 13.25m (approx.).

3. CONCLUSIONS

In this project we tried to shed some light on the controversial issue of breakage of the Idukki (Cheruthoni) dam in the eventuality of the collapse of Mullaperiyar dam. According to the information we collected from the Dam safety authority officials, it is to be concluded that both the dams are safe and the chance of the above described scenario is remote. But a numerical analysis based on the factors as described in [2] led us to the conclusion that the collapse of Mullaperiyar dam may lead to the formation of tsunami like waves which can be higher than the Cheruthoni dam. It is also to be kept in mind that, if water overtops a gravity dam, the dam will topple.

This work is just a pilot study and the numerical calculations are not rigorous. Also, we did not calculate the kinetic energy of such waves because that calculation cannot tell us whether it will be enough to break the Cheruthoni dam. This is because, the data needed to calculate the strength of a dam is not available to us.

So, this work is only the first step in this direction. But even with this small research project, we have partially succeeded in showing the possibility of the failure of Idukki dam. Hence it is to be concluded that the fear of the common public in this regard cannot be ruled out entirely.

ACKNOWLEDGEMENT

We are thankful to all the faculty members and non-teaching staffs of the Department of Physics, Catholicate College, Pathanamthitta who have extended their kind cooperation. I am taking this opportunity to thank all the officers of KSEB and Dam Safety Organization who have helped us to make this project a successful one.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

REFERENCES

[1] Distance between dams and catchment areas cannot be calculated in a practical way. Our way of calculating these types of geographical measurements were done with the help of Google Earth. https://www.google.com/intl/en_in/earth/

[2] The concept of formation of waves when two large water bodies collide was an article which was written by retired Chief engineer M. Sasidharan, member of the Inter State Water Advisory Committee for The Hindu. https://www.thehindu.com/news/national/kerala/cheruthoni-kulamavu-dams-may-not-survive-ifmullaperiyar-collapses/article2694363.ece/amp/

[3] The principle of large circular oceanic waves due to volcanic eruption in the middle of the ocean was considered with help of a reference website called montessorimuddle.org http://montessorimuddle.org/page/11/?s=math+pi

BIOGRAPHIES

Dr. Anoop P D
Assistant Professor
Postgraduate and Research Department of Physics
Catholicate College, Pathanamthitta

Ruben A Varughese
Student
Department of Physics
Catholicate College Pathanamthitta

Sajna K Anas
Student
Department of Physics
Catholicate College Pathanamthitta