Increasing Capacity of Reservoir Using Fusegates

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***Abstract*—Fusegate are a new type of spillway discharge design which are used to store water and discharge it in a effective way together to get more water. Dams are used mainly to store water, but when there is excessive rainfall around low rise dams, the surplus water get washed off and the fusegate system enables us to store this excess water in the reservoir. And this excessive water can be use for the other domestic purpose and industrial as well, There is a need to install these type of fusegate to store water for socio-economic development of a nation. All though the installation of gates with different types and heights might practically difficult , but its lower annual cost , flexibility in operation and smaller wasted water resulting from gates tipping justifies their selection Floods have been and are the main cause of dam failures. The criteria and methods for designing spillways vary from country to country, but are usually based on traditional practice established when the knowledge of risks was not the same as it is today. They have the following serious drawbacks: 1) They overlook the serious risk of gates completely jamming, 2) They do not focus enough on costs, and thus overlook or prevent low-cost solutions which may be the key to safety (halving the cost for spilling $1m^3/s$ makes it possible, for the same cost, to double the spillway capacity, and thus to divide by 100 the failure probability).**

***Index Terms*—embankment, fusegate, hydroplus, reservoir, spillway**

I. Introduction

Every developed country stores water for about 1000 days so that they can be well prepared if famine conditions arises in their vicinity. In India specially in Maharashtra, loss of lives and livelihood occurs due to scarcity of water. So the application of these fusegate technology. The excessive water stored during monsoon and springs can be used in the month of April and May, just enough to save the lifes and livelihood of our farmers. In last few decades there has been many increasing the storage capacity of existing reservoirs might be considered an economical and effective alternative. Fuse gates installation is a comparatively new alternative, which has increased in popularity during recent years due to its numerous advantages. Since their first real-world application in the Lussas Dam in 1991, they have been widely used in over 50 dams all over the world and have gained considerable recognition as a safe and economical tool for providing extra water supply (Chevalier, 2004). Fusegates are essentially a technical method to increase the maximum water level without structural dam heightening. Fusegates may be efficiently implemented to increase spillway capacity without sacrificing existing reservoir storage. In fusegates system, gates are placed side-by-side to fill in the original spillway width. (Afshar and Takbiri, 2012). The fusegated spillway is favoured to pass the design flood with maximum water level not exceeding that of original free spillway. Different gates combinations, their setting aprons, and varying routing characteristics of the fusegated spillway should be employed to fulfil this requirement. The principal advantage of fusegates over fuse plugs lies in their operational schedule. Fuse plugs completely fail when they overtop whereas a number of tipping fusegates depends on flooding conditions and design tipping head of the individual gates. Fusegates were invented in 1989 by Francois Lemperiere as a simple, robust, and safe system to increase live storage or spillway capacity. The system has been patented by Hydroplus International in the United States, Europe, and most other countries. It is implemented in more than 40 dams in 14 different countries across 5 continents (Falvey and Treille, 1995). This system can be a good alternative for radial gates without any need to mechanical and electrical equipment and continuous maintenance.

II. Objectives

- The main objective of this study are as follows:
- To increase the water saving capacity of the reservoir
- To avoid the early failure of the embankment.
- To make the reservoir more flexible in their use and make optimum use of the topography.
- To reduce the overall cost of construction.
- To make the construction fast & in a very feasible manner.
- Rather going for building a high rise dam it is easy to construct a fuse gate which ultimately increases the capacity with low investment.
- To increase about 20-30% of water capacity of the reservoir.

III. Methodology

1) Fusegates are made of concrete and steel and are installed side by side on the dams spillway crest. They may also be provided in the midway of the dams before construction.
2) Fusegate system was initially tested in the United States and since then they are used in many parts of the world as a solution to prevent overflow of water.
3) In Africa this fusegate system was successfully adopted on a small dam and it proved to be a perfect solution.
4) Our project aims to implement this idea and development of fusegate technology in India so that the excess of water can be efficiently stored and later can be used for different purposes and benefit the people of India.

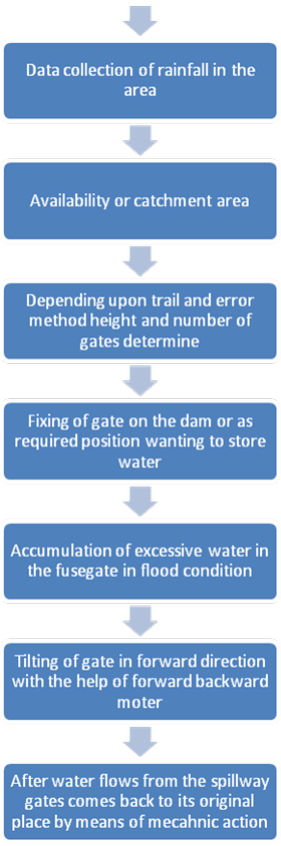

Fig. 1. Flowchart

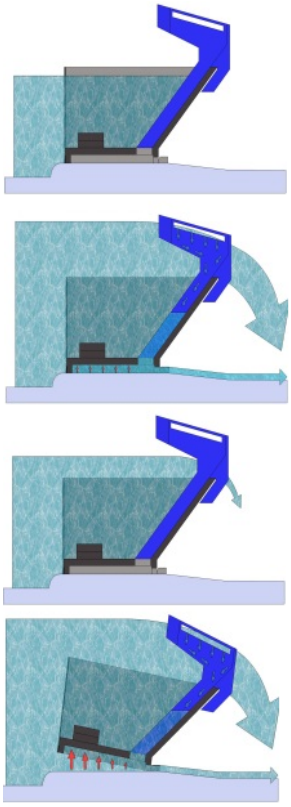

Fig. 2. Working of fusegate

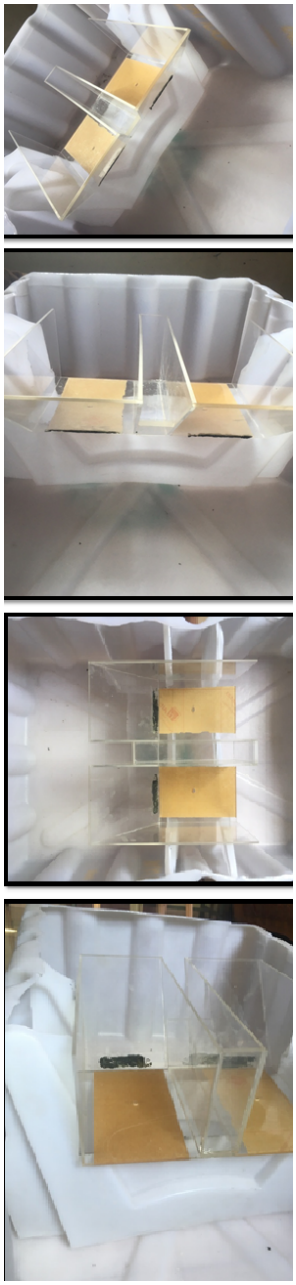

Fig. 3. Hardware setup

IV. Criterion for Selection

The interaction of the downstream toe abutments with the ballast in the fusegate guarantees the stability of the unit against the water pressure. Precise adjustment of the drain hole enables the base chamber to be drained of any accidental leakage while ensuring a rise in pressure once the inlet well begins to fill. Set at a predetermined level, the filling of the inlet well is set to coincide with the tipping level of the fusegate. The reservoir level is then increased to reach the top of the crest of the fusegate modules. In flood conditions, when the reservoir is full, the water flows over the crest of the fusegate, which acts like an ungated spillway. In exceptional flood conditions, the water level in the reservoir reaches tipping point: water pours into the inlet well to flood the base

chamber. Once the drain holes are saturated, pressure builds up beneath the module. This generates a discontinuity in the force ratio which leads to destabilization of the fusegate, causing it to overturn in the downstream direction. As the water level continues to rise, the fusegate modules tip sequentially, one after the other. Their tipping threshold is set precisely by the height adjustment of their inlet well, to ensure that the units overturn progressively in order to compensate for the effect of exceptional flood levels.

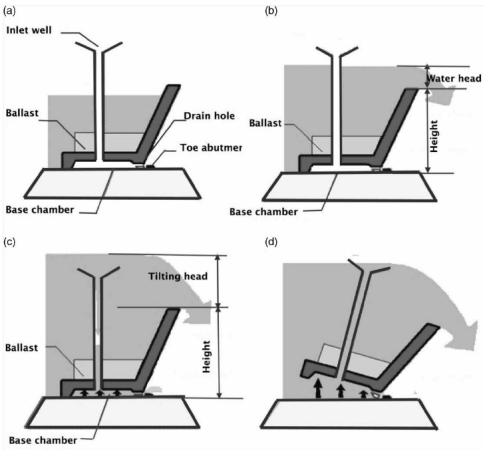

Fig. 4. Hardware setup

V. Design Procedure

To ensure that the spillway can pass the design flood (in many cases the probable maximum flood), ail of the fusegates should have tilted at a reservoir elevation less than the maximum reservoir elevation. The determination of the design elevation at which the last gate tilts is obtained by trial and error. First, a reservoir elevation for the last gate to tilt is assumed. From this elevation, the height of the fusegates and their number is determined. Then, using a flood-routing program, the design is verified. That is, a check is made that the maximum reservoir elevation is not exceeded for the assumed design elevation and the incremental increases in discharge. If the maximum reservoir elevation is exceeded, the design procedure is repeated with a lower design elevation. If the reservoir elevation is not exceeded, the design procedure is repeated with a higher design elevation. The goal is to determine the maximum reservoir elevation for tilting of the last gate. Achieving this goal ensures that the maximum amount of water will be stored in the reservoir without jeopardizing the safety of the dam. Sometimes, the crest elevation of the fusegates must correspond with the normal pool elevation. In this case, the spillway crest elevation is adjusted to achieve the required pool level using the standard gate heights and the procedure is repeated.

VI. Conclusion

The orientation of the fusegate mainly depends upon the following factors: a) topography of the land, b) amount of rainfall in the region, c) requirement of the region, d) climatic condition, e) existing water level in the reservoir, f) hydro-pressure,

Every developed country has water storage for about 1000 days and for the under developed nation it is about 150 days i.e. approximately 5 months. Therefore, this project provides a solution to increase the water height level of a reservoir.

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