Techno Feasibility Analysis and Design of Inflatable Rubber Dam

[1]Mr. Giri Prakash Laxman, [2]Prof.Shirsath M. N.

[1]Student, [2]Vice Principle,
[1]Department of Structure Civil Engineering,
[1] G. H. Raisoni College of Engineering & Management, Ahmednagar, India.

Abstract:

Use of a rubber as a construction material is not new for us as it is widely used in the construction industry. But rubber can be used as a material for construction of dam or as a water retaining structure. In countries like Europe, Japan, Australia, USA rubber dams are constructed as its low construction cost and easy in its operation and maintenance. Our aim is to present actual calculations and various design aspects of rubber dam. In this we are going to put the future applications of rubber dam instead of bandhara, small dams, kt weirs etc. and its use for water irrigation.

Rubber dams are flexible cylindrical inflatable structures attach to a rigid base and inflated by air or water this type of dam is being used for the past 40 years in river and coastal engineering application due to elasticity property of the structure and continuous variation of its shape during operation, rubber structural and hydraulic structure is more complicated than a rigid dam.

There are number of rubber dam have been installed in worldwide for various purposes such as irrigation, water supply, flood control, electricity generation in hilly areas and maintain the ground water table near ground etc. Rubber dam is a new technology which control water in flexible way.

Index Terms – Rubber Dam, Rubber Membrane.

I. INTRODUCTION

The rubber dam is widely used because of its simplicity, placement construction and operation they are used for various purposes such as delivering water for irrigation, flood control, tidal defense, recreational purposes, preventing contamination and raising the height of existing height of dam to increase the reservoir capacity. Rubber dams are easy to install, do not corrode, require less maintenance can handle extreme temperature. This type of structure is considered as more economical compared to the rigid type of control structure constructed with concrete, masonry and steel.

Rubber dams are long tabular shape fabric placed across channels, steams and weir crest to raise the upstream water level when inflated. The finite element analysis is needed to get the stress of the multiply, composite material with cover layers of rubber. Because of the rubber layer the inflatable dams are sometimes called rubber dams.

Rubber dam is a rubber tube that is installed along the cross section of the river and width full and empty it by using compressed air or water created as an obstacle with the desired height on the way of river water. Feeder system in these dams guides the air or water as a filling material into the rubber tube.

II. OBJECTIVES

- Object of this project is to find the shape and tension of the membrane of the dam for a given upstream and downstream head, base length, membrane length, internal pressure and properties of the membrane.
- The shape of the dam is a function of external forces due to upstream head and downstream head and internal forces due to the inflation pressures and weight of the membrane.
- The shape and tension of the membrane was calculated using a finite element approach under various hydrostatic conditions detail in chapter 4.
- To find the analysis and design of inflatable rubber dam which is suitable to the Indian topography.
- To make people aware about the safety of a dam and make familiar to the application of a inflatable rubber dam.

III. LITERATURE SURVEY

Adil Dawood Alwan [1] has proposed a topic the analysis and design of inflatable dam in November 1997 by publisher Imagine services north, west Yorkshire. Adil studied on an alternative method to overcome the height cost and time required for the design. He also did material testing an get results of material.

H. chanson [2] proposed a paper on Hydraulics of rubber dam overflow: A simple design approach in December 1998 by publisher Monash University, Melbourne, Australia. Chanson proposed theory about the hydraulic characteristics of the crest were investigated separately and result were presented by chanson.

M. Gebhardt [3] proposed subject In Inflatable structures in hydraulic engineering studied in September 2013 and publisher BAW; federal water ways research institute. In these paper Gebhardt says about the objective of working group166 “inflatable structures in hydraulic engineering”, covers some results of recent investigations and gives an outline of the first experiences with design.

Dayton Tagwi has proposed a subject Inflatable weir hydraulics In March 2015 publisher Stellenbosch. University (MSC Engg.: water). His aim to evaluate the hydraulics of an inflatable weir in its fully inflated position to the almost fully deflated position using diameter circular weirs.

IV. PROPOSED DESIGN

4.1 Study the design parameter of rubber dam: -

Base length of dam is denoted as B. Length of the membrane element is L also the total length of rubber membrane is denoted by TL. R is the radius of curvature of crest of dam. P is the internal air pressure and Ymax OR H is a maximum height of dam. T and ϴ is the tension in the membrane and initial upstream slope of the dam at the upstream fixture.

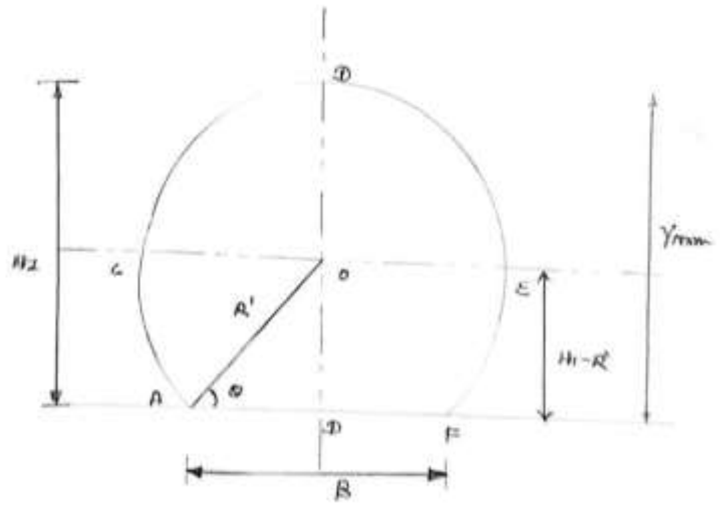


Fig. 1. Assuming rubber tube fill by air to find basic parameter shown in fig.

From the above figure we found the B, H, R, TL by using simple geometric formulas.

4.2 Design of rubber dam: -

Calculating internal pressure by using formula P=AT\R and from the internal pressure find initial tension and slope by the

$$T=P1xR' \text{ and } \tfrac{1}{2} \times \gamma \times (UH)^2 = T + TCOS\Theta 1 + 1/2 \times \gamma \times (DH)^2 \text{ respectively,}$$

Now divide the rubber membrane into number of parts and design the elements are as follows,

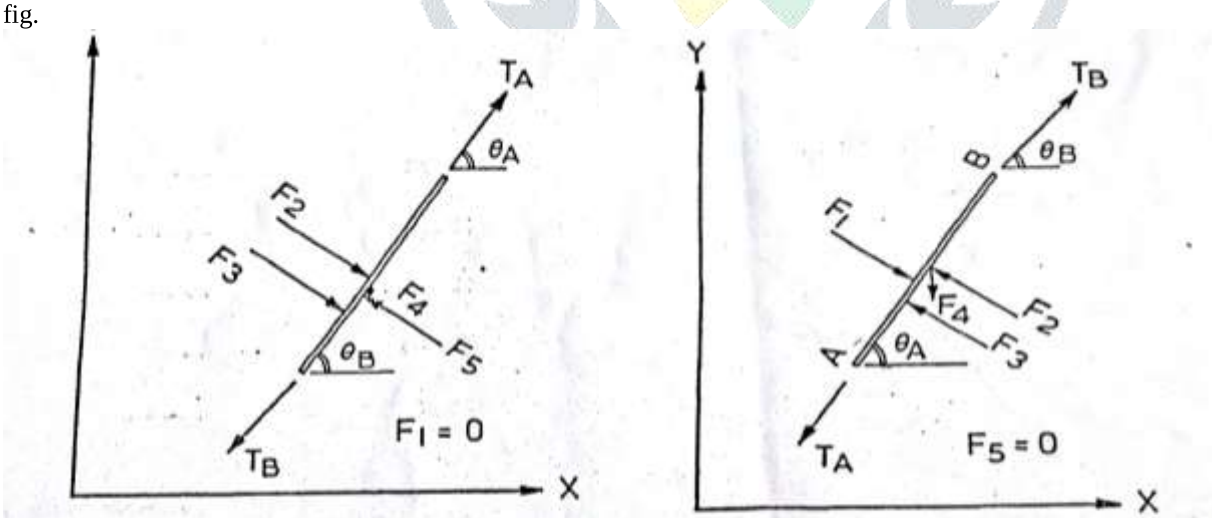
Find the change in length by using formula $\mathcal{E}=\Delta L/L$ where, $\mathcal{E}$ is stain and which is calculated by formula,

$$\mathcal{E} = C1 + C2\,\sigma + C3\,\sigma^2 + C4\,\sigma^3$$

where, C1, C2, C3, C4 are the coefficient for the N.T. fabric which is taken from the literature 1 research paper.

Co-ordinate position of points on the profile can be calculated by $X= (L+\Delta L)\ COS\Theta$ and $Y = (L+\Delta L)\ SIN\Theta$ respectively,

Then find forces acting on the dam or element that is Upstream hydrostatic force, Internal air force, Internal water force, Weight of membrane force respectively, forces acting on the both side that is upstream side and downstream side of the dam which is shown in the fig.



(2)

Fig. 2. Fig 1 shows upstream forces and Fig 2 shows the downstream forces acting on the element.

By using equilibrium equations find T_B and Θ_B

$$T_B\ COS\ \Theta_B = T_A\ COS\ (180- \Theta_A) + (F1-F2)\ COS\ (\Theta_A-90)$$

$$T_B\ SIN\ \Theta_B = T_A\ SIN\ (180- \Theta_A) - (F1-F2)\ SIN\ (\Theta_A-90) + F4$$

When T_B and Θ_B have been found they form the new T_A and Θ_A for the next element and process can be repeat for the whole element.

After solving the all elements, we get the coordinate to draw the profile of inflatable rubber dam so the profile is as follows

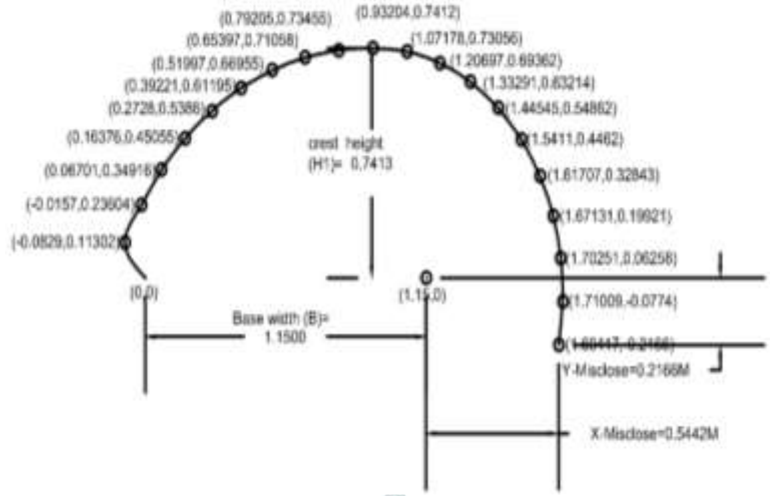


Fig. 3. Initial profile of rubber dam.

From the above diagram we get the x- mis close and y-mis close to reduce the x-mis close and y-mis close we have to adjust initial tension and slope (T_A and θ_A). After adjusting it become a $T_{adjusted}$ and $\theta_{adjusted.}$ The procedure of $T_{adjusted}$ and $\theta_{adjusted}$ are as follows

$$T_{(Adjust)} = T – [X \text{ x } \delta y/\delta\theta – Y \text{ x } \delta x/\delta\theta] / z$$
$$\theta_{(Adjust)} = \theta – [Y \text{ x } \delta x/\delta T – X \text{ x } \delta y/\delta T] / z$$

were

$$Z = [\delta x/\delta T \text{ x } \delta y/\delta\theta] - [\delta y/\delta T \text{ x } \delta x/\delta\theta]$$

By taking $T_{(Adjust)}$ and $\theta_{(Adjust)}$ as a T_A and θ_A and repeat the above whole procedure (take iteration) until the X-misclose and Y-misclose reduce to the predefined limit.

V. RESULT ANALYSIS

Table 1. Result of inflatable rubber dam.

SR.NO.	Description	Value
1.	Upstream head	1 Meter
2.	Downstream head	0 Meter
3.	Allowable Tension	15KN/m
4.	Air Pressure	18.036637 KN/M^2
5.	Water Pressure	0 KN
6.	Original length	2.79155 Meter
7.	New Length	2.8028918 Meter
8.	U/S Tension	10.92 KN
9.	D/S Tension	14.5665 KN
10.	Base Length	1.15 Meter
11.	Max. Height	1.00 Meter

After solving all the iteration, we get final profile coordinates. Form that final profile of rubber dam is drown as follows

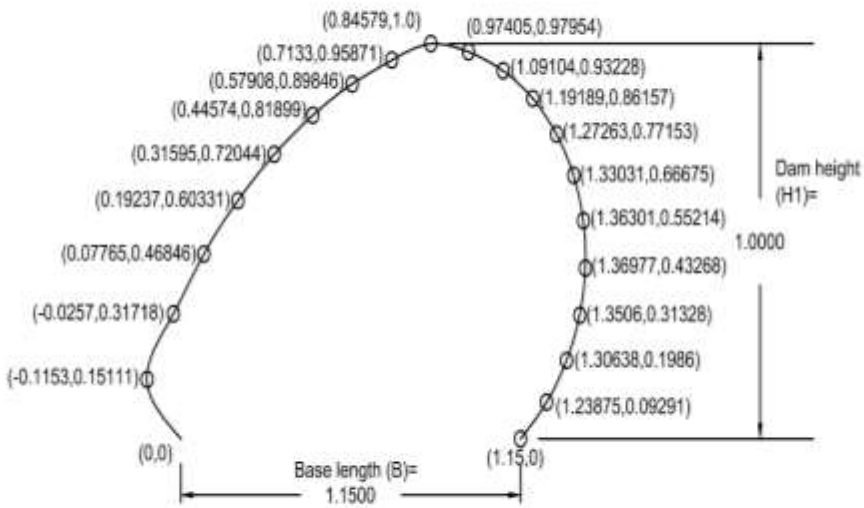


Fig. 4. Final profile of rubber dam.

VI. CONCLUSION

"Techno feasibility analysis and design of inflatable rubber dam" From the above work of analysis and design of air inflatable rubber dam, we can conclude that the air inflatable rubber dam of pre-defined height is safe for a given hydrostatic condition as per the above design.

As the rubber dams have low height. It can be easily implemented in practice for irrigation, increasing ground water discharge, domestic purpose etc.

We have made a working model of air inflatable rubber dam. And it has been successfully worked.

The ability of such a structure to fold flat on its foundations when not required for use and to rise into its working position when required, offer many advantages over a conventional water control structure.

VII. REFRANCES

I. "The analysis & designs of inflatable dams", by Adil Dawood Alwan (University of Sheffield) (Nov-1979).

II. Hydraulic of rubber dam overflow – A simple design approach by H. chason 9 university of queensland, Australia) (Dec-1998).

III. Design & analysis of r/f rubber membranes for inflatable dams, by R. Gurt, M. Dantscher& M. Gebhardt. (2015).

IV. "Inflatable weir hydraulics", by Dayton Tagwi. (March2015).

V. Evaluating the design construction and use of rubber dam by Yousef parish (internal journal of advance biotechnology and research ISSN 0976-2612 Vol-7, Issue-1 2016).

VI. "Rubber Dam-Design and construction aspects under Indian environment."by V.K.Shivare, Amit Bansal, Karan Varma.(International Journal of Engineering technology science and research. ISSN 2394-3386, Vol-3, Issue-5 May-2016).

VII. Improvement and scale enlargement of the inflatable rubber barrier concept, by Marjolein Van Berukelen.

VIII. Analysis of inflatable dam under hydraulic conditions, by Karin K. EL- Jumaily& Eng. Abdulah Ali Salih.

IX. Rubber dams- Effective Method to improve upstream flow of river, by DG. Paedehi, Ketan. S Mahajan.

X. "Sitability of rubber dam as a river water management tool" by Vipin Yadhav, Darshan Mehta and Sahita Waikhom.