Rubber Dam and Its Prospect

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Abstract: The term ‘Rubber Dam’ sounds strange and gives an obvious impression that it might be a dam made of rubber. The concept of rubber dam is developed very recently in India and comparatively new. Though the system has been used in great extent in countries like China, Australia and in Scandinavia till date very few countries have used. It is used in site specific cases where it may prove to be very good alternative. A rubber dam has many advantages, such simple hydraulic structure, short construction time, perfect seismic performance, and low resistance to water flow in flood season etc. General description of the system and functional principle has been presented in this paper. A case study of the first rubber dam in India, “Jhanjhavati rubber dam” over the Jhajhavati River is also presented in this paper.

Key Words: Rubber Dam, Inflatable structure, Minor Irrigation Dam, Flexible Dam.

I. Introduction

Rubber Dam is a different type of hydraulic structure compared to a conventional water retaining structure with gated or un-gated spillways and weirs to release the surplus water, such as dams and barrages. Strictly speaking these are not dams, but structures made of high strength fabric adhering with rubber, which forms a ballooned rubber bag when filled with water or air and anchored to the basement concrete floor, and are used for water retention. Such type of a water retaining structures (Rubber dam) themselves could also serve the purpose of releasing the surplus water over the body of the dam by emptying filled water or air from the dam bag, which are mostly used for flood release.

Rubber dams have been used in China over the past 40 years as cheaper water conservation structures compared to conventional gated structures like barrages especially in small and medium rivers. Rubber Dams have wide prospect in the world since they can be used especially for irrigation, for pisciculture, hydropower generation, environmental improvement and recreation purpose. Rubber Dams are not known to have other than beneficial impact on environment and ecology. Rubber Dams have certain definite advantages, within their applicability range; over conventional gated regulating structures like Regulators and arranges.

II. Advantages Of Rubber Dam

Replacement of heavy gates, hoisting gears and piers of conventional structures by light rubber-nylon shell body saves huge amount of steel, cement, timber and other construction materials. This brings the economy. The dam body can be fully deflated to lower it to flat level on base floor so that flood flow passes without any obstruction. This provides rubber dams a dominant position over conventional gated regulating structures. Rubber dams can have spans as long as, 100 meters without dividing piers. This provides full width of active cross section of the river channel to release flood flow. Load of dam body is evenly distributed on foundation. This lessens treatment of foundation soil, sometimes, to only nominal or none.

Construction and installation are quicker compared to conventional gated regulating structures. Total investment cost is 30-40 % lower than that of conventional gated regulating structures.

No gates and hoisting gears make operation of the structure simple. The dam bag needs very little maintenance. Repair to damages of the dam bag is simple and can be done by ordinary skilled staff with simple tools.
1. Flexibility: The height is very much flexible as per the requirement.
2. Safe flood release: Excess flood automatically released lowering the dam height without help of mechanical components.
3. Less energy requirements in comparison the mechanical gates.
4. Very long span upto 100m can be adopted, reducing number of piers.
5. Absence of mechanical components reduces corrosion risks.
7. It can be transported and reused at other locations.
8. Lesser time for construction/installation (six months)
9. It can avoid large scale submergence/ Forest lands

III. Prospect Of Rubber Dams

A. Rubber Dam for Flood Control

There is a large potential for exploitation of surface water from small and medium rivers of the country for irrigation and Rubber Dams would be ideally feasible water retention and conservation structures for such rivers which are characterized by low flows and water levels during post monsoon and winter seasons when retention is need and by high flood flows in monsoon season when unobstructed flood passage is desired.

B. Rubber Dam for Irrigation

Rubber dam being deflatable to open the full passage way of the river channel during monsoon flood s are ideally feasible water conservation structures for many small and medium rivers and will thus play a vital role in enhancement.
Rubber Dams can be used to conserve water in channel storages of small and medium rivers and streams in flat areas and in small reservoirs in hilly areas for the principal purpose of irrigation. Some countries have too little rainfall in winter. So, the requirement of water for winter irrigation must be met from groundwater source and by conserving a part of monsoon surface water in suitable storage. Such countries have introduced Rubber Dams, a cost effective technology for retention and conservation of surface water in river channels, reservoirs and lakes for the purpose of supplying irrigation water to winter crop cultivation. Though Rubber Dams can be used for all purposes where water retention is involved, these are ideally suitable for conversation of water in channel storages of rivers and channels as the Dams can be inflated to retain river flows and deflated fully to allow passage of flood flows without any obstruction whatsoever.

C. Rubber Dam for Hydropower

In the perennial small streams run-off the-river schemes are normally done with smaller head.

In those cases the rubber dams are proved to be very much efficient. In Europe rubber dams are being used since late seventies.

D. Rubber Dam for Water Conservation

Conservation of surface water is of immense importance to many countries to sustain growth of agriculture through better water and irrigation management in face of nature uneven distribution of water throughout the year in one hand and prevent its environment and eco-system from plunging below dangerous level of degradation in face of artificial shortage of water in its rivers and streams created by unlawful withdrawal of lean season low by the upstream country or region on the other. It is therefore necessary to exploit possible ways and means of surface water retention and conservation, especially the ones which are cost effective and suitable for the low and flat physiography of some countries. Rubber dam is one of such means of promise to retain and conserve water in reservoirs, lakes and channel storage of small and medium rivers of the countries.

The 84 m long 3.5 m high water filled Bakkhali Rubber Dam in Bangladesh is in a tidal environment not far from the Sea and separates downstream saline water as it impounds upstream sweet water flow in the river and tributary channels. Water is lifted from about 12 km long channel storage by 111 L. LLs under private management to irrigate 6000 ha land for winter rice (Boro)cultivation in 84 blocks.

E. Rubber Dam in Watersheds

Application of rubber dams in watershed scale is very few. Development of water resources in watershed scale needs implementation of small structures like check dams, diversion weirs etc. all these structures are designed by taking rainfall of 10 year return period. If relatively larger storage is required them one might consider the rainfall of 25 years return period. But when the rainfall exceeds this amount, the structures become liable to failure leading to damage of structure, loss of economy and bad environmental impact. This problem can be alleviated by use of rubber dams in place of conventional check dams because the head wall portion is of inflatable and deflatable type. In case of erratic rainfall resulting unpredicted runoff, it can be deflated and thus allowing the runoff to pass over the structure safely without causing any damage to the structure. So in this way it gives some kind of operational flexibility.

F. Rubber Dam for Special Problems

At the need of a flexible structure this can be a feasible solution. The example of the Jhanjhavathi dam is a typical example where an interstate issue could be addressed by Govt. of Andhra Pradesh.

IV. A CASE STUDY - JHANJHAVATI RUBBER DAM

A. THE PROJECT

The Janjhavathi Reservoir Project is a Medium Irrigation Project across Janjhavathi River in Vizianagaram District, A.P., to irrigate an ayacut of 9970 ha (24640 acres). The project is contemplated to utilize a yield of 113.28 Mcum out of total available yield of 226.56 Mcum as per the Inter State agreement with Orissa State. The project was commenced during 1978 with an estimated cost of Rs.51 crores. The project envisages an earth dam in the right flank 3.15km, a concrete non-over flow section of 278m length (including the river gap portion), 6 bays of spillway block of 15m length in the left flank, and left earthen dyke of 850m length. The earth dam portion
including the canal outlet (HR) and concrete non-overflow section of 218m out of total of 278m is has been raised upto 15 to 25m.

The spillway potion has been raised upto the bridge level. In the river gap portion, for a length of 60m where the present construction is stopped at RL 122.3m due to non-settlement of issues between Orissa and Andhra Pradesh regarding submergence of 1038.60 Acres (as stated) of land in the Orissa territory. Reportedly, the canal system is complete. But as the reservoir has not been formed Irrigation could not be provided.

This situation led to make an alternative temporary arrangement for providing irrigation to a part of the ayacut by providing a flexible water retaining structure, the Rubber dam over the partly constructed dam base in the river gap portion (60m). By this provision the water could be stored upto 3.1m height, i.e., upto RL 125.44m and the water is released through the construction sluice to a diversion canal of 3.5km length which joins the already constructed canal system at about 2.56km on the down stream of the HR. By this they are able to irrigate 9000 acres in the proposed ayacut.

VI. DESIGN ASPECT OF THE DAM

The Rubber dam has been manufactured at the manufacturer’s plant in Austria and has been transported to the site and installed by the engineers of the manufacturer.

Detailed design aspect of the Rubber dam was not available at the site and could not be known. However some preliminary information were made available from the brochures.

1. Body: The inflatable bladder is made of heavy duty, nylon reinforced rubber that withstand heavy abrasion. The thickness varies from 9.5mm to 25mm depending upon the dam height. At Janjhavathi, the foil is double-clamped and has a wall thickness of 12.0mm, with three woven fabric reinforcements with rupture strength of 75.0t/m.

2. Anchor: The bladder is anchored to the foundation using a simple clamping system composed of anchor bolts and steel clamping plates. The simple design procedure is extremely reliable for water tightness. The system can be installed with much lesser time with the help of standard tools.

3. Side Slopes of Face Butting the Dam: Rubber dam can be installed in the river with any side slopes angle, eliminating the necessity of modification to riverbank, unlike steel gates, which can only be installed on vertical side slopes. At Janjhavathi both side faces were vertical.

4. Foundation: The rubber dam can be laid on the new foundation or on the existing structure. Normally the concrete foundation is laid on a firm base and made a horizontal base for fixing the sheets of rubber.

5. Span: The rubber dam permits very long spans, thus reducing the need for intermediate piers necessary for the steel gate installations. The long span of the rubber dam also maximizes the discharge as there are few piers obstructing the waterway. Janjhavathi Rubber dam is having two spans of 30m each.

6. Water Filling/Release Arrangements: There are four shafts on the right bay of the Janjhavathi Rubber dam, two for the filling the dam and two for release of water from it. For each bay (span) of the dam, one separate pipe for filling and release of water are provided at the bottom of the dam (embedded in the base concrete) leading from the corresponding shafts.

VI. OPERATION

For filling the dam water is pumped from the river on the upstream of the dam by the pump installed in the pump chamber (first shaft) into water filling chamber (second shaft), which is connected, to the dam through the filling conduit and controlled by a valve. The Rubber foil is filled with water in gravity by opening the valve, when inflation of the dam is required. Similarly at the time of deflating the rubber foil, water is released by opening valve in the dewatering chamber (third shaft), which leads to the fourth chamber, from where water is released to the river through a conduit by gravity.

The valves can be operated manually. An arrangement of electronic control panel for remote control with the motorized sluice valve is there in addition to the manual operation system. It was observed that highly technical personnel are not essential for operation. Only ordinary skilled labour/fitters/mechanics with training can operate the system.

For safety, an automatic deflating arrangement exists. When water level in the upstream rises above a prefixed level, the water from the dam automatically squeezed out and the
rubber dam sinks allowing the water pass over it.
An additional emergency discharge system through a drainage pipe can function by gravity. The discharge device consists of a container, which fills with water and opens at present over flow. The container then empties automatically.

VII. CURRENT RESEARCH

Current research is being carried on at Directorate of Water Management, Govt. of India, and Bhubaneswar. There is planning for installation of small indigenous rubber dams near Chandeswar in Kusumi Nalla and one in the research farm at Deras in Odisha. The concrete foundation for the dam has already been constructed. The prototype rubber dam has already been tested at Indian Rubber Manufacturing Research Association (IRMRA). It is working perfectly. The inflating and deflating mechanism is working satisfactorily. The pressure is measured. The hydrostatic pressure is within 2 kN/Sqm. By creating eddy current as well as higher velocity in upstream there was no damage to the rubber dam. The broken bottles and heavy weight debris was forced to flow from upstream to pass through rubber dam and no structural damage was noticed. Therefore, the structure is expected to function successfully.

VIII. CONCLUSION

After visiting the Rubber dam site discussion with the Engineers of Irrigation Department, Andhra Pradesh and the representatives of the IMCC it was felt that there are certain definite advantages of the Rubber dam though few disadvantages are anticipated.

Some Limitations/Disadvantages Anticipated are:
1. It has got limitations of height. It can be used upto 5.0m height.
2. Cannot be used in large dams, only can be used as diversion weirs.
3. The initial cost is higher.
4. In absence of technology transfer, the long-term maintenance may be a problem.

However, in spite of few anticipated disadvantages of the system may be very much useful in the diversion schemes of Minor Irrigation Projects. It may also be very much useful in renovation of existing Minor Irrigation Projects.

REFERENCES