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Suitability of Rubber Dam as a River Water Management Tool

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Abstract*—Rubber dam is a relatively new type of hydraulic structure compared with steel sluice gate, weir, causeways, etc. which is made of high strength fabric adhering with rubber forming a rubber bag. The barrage, made of rubber, will be filled with air, so that it can be inflated or deflated as per requirement. The concept of rubber dam and its application in India has yet to develop to gain from its advantages, though the system has been used in great extent in countries like China, Australia and in Scandinavia. It is used in site specific cases where it may prove to be a very good alternative to costlier permanent structures. A rubber dam has many advantages, such as simple hydraulic structure, short construction time, perfect seismic performance, and low resistance to water flow in flood season etc. General description of system, various configuration and types, working principle and comparative analysis has been presented in this paper. Also, its usefulness from various perspectives is highlighted considering the high and low discharge available in the stream, combined with tidal effects of low and high tide due to its close proximity with Arabian sea. The benefits of establishing a rubber dam could be even greater than a multi-purpose reservoir as it entails much lower cost, and construction viability and flexibility with minimum ecological and environmental set-backs. Combined with water management of urban area this could be a very effective tool of river water management, especially for cities near the banks of rivers.

***Keywords*—Rubber dam, river water management, flood control, water barrier**

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, 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. Rubber is inflatable and deflectable material and some the hydraulic structures may be located in cold areas where the temperature may be as low as – 40°C. The water-filled construction of Rubber Dams can be constructed for water heads even from 0.3 meters to more than 3 meters. There are many distinct comparisons of conventional dams and rubber dams.

II. CHARACTERISTICS OF RUBBER DAM

A. Types of Rubber Dam

- Color Rubber Dam
- Arch Rubber Dam
- Slopes Rubber Dam
- Book Back type Rubber Dam

Color Rubber Dam
The color Rubber dams are finished with colors outside. The water overflowing the dam tubes looks like colorful waterfall against green bushes around. As a result, urban areas and gardens where the dam id used do not only function for water control but also help develop water entertainment and tourism.

Arch Rubber Dam
Arch rubber dam is derived on the basis of a new type of rubber dam technique, with a curved bar for innovation in the structure. Flexible curve to achieve practical results both the United States there are beautiful results.

Slopes Rubber Dam
Beautiful dam slope straight shape when the dam bags cloth bags of retaining uniform force Medium of filling and water overflowing conditions.

Book Back type Rubber Dam
The section shapes of this kind of Rubber dam is like the book structure with smooth appearance made and vulcanized in the factory this kind of Rubber dam improves the transverse tension reduces the vibration and water overflow bump of the dam tube. Water overflow scene of the dam tube is beautiful and attractive. Smooth surface of the dam tube can make the

book back type Rubber dam complexly flat when discharge the dam tube.

III. OPERATING PRINCIPLES

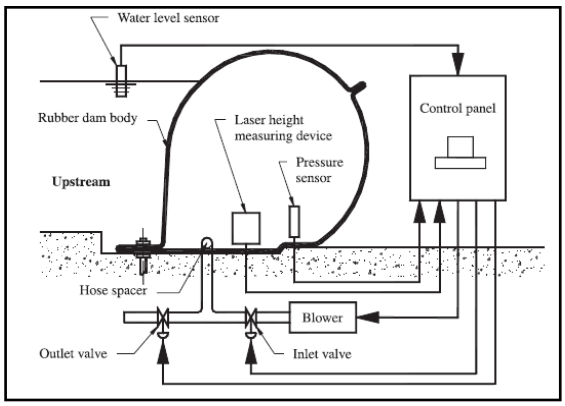

Figure 1- Operating Principles

Inflatable dams can be filled with water, air or both. They are low pressure - typically 4 to 10 psi. The present trend suggests an increased use of air-filled membranes because they can be deflated or inflated more rapidly, and they are little affected by freezing conditions. Characteristic dimensions cover typically lengths of about 100 m with specially-made membranes up to 200-m wide, dam heights usually less than 5-m but some special designs might be up to 10-m high. The membrane is usually deflated for large overflows. It is however common practice to allow small spillages over the inflated dam. During overflows greater than 20% over-topping, vibrations might result from fluid-structure interactions. In practice, a deflector (i.e. fin) is installed on the downstream face of the rubber dam to project the nappe away from the membrane, hence preventing rubber membrane vibrations.

IV. MAINTENANCE

Although various preventive measures have been taken to reduce the incidence and extent of damage to rubber dams, these cannot be completely avoided. Corrective maintenance is performed to restore malfunctioning units to a satisfactory and safe condition within the shortest possible time. Damage of the dam body can be classified into four types:

- Small puncture
- Surface damage
- Small area damage
- Large area damage

Repairing Small Puncture (Bullet Hole)

The air pressure record can be used to analyze whether or not a dam is leaking. A suspected hole in the dam body can be found in two ways. The submerged portion can be checked for air bubbles coming from the dam body, while the portion above water can be coated with soapy water and inspected for bubbles caused by air leakage. The simple method to repair automobile tires by inserting plugs can be deployed to repair small punctures (e.g., bullet holes) to a rubber dam. One advantage of this technique is that it does not require the damaged area to be dry.

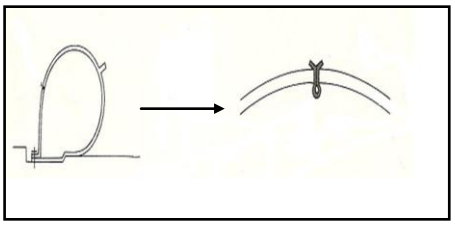

Figure 2- Repairing Small Holes

Repairing Exposed Fabric

To repair surface damage, the following simple procedures are adopted:

- Cut off the outer surface of the damaged area.
- Fill self-vulcanizing rubber into the damaged area after cleaning and drying.
- Smooth outer surface by removing protruding rubber materials.

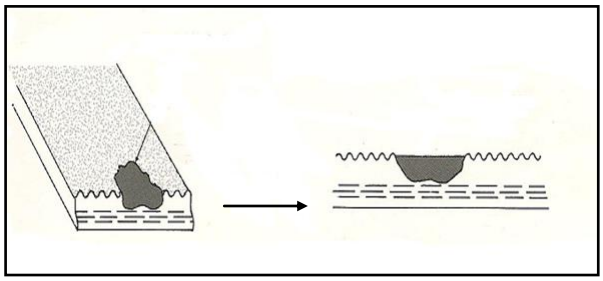

Figure 3- Repairing Exposed Fabrics

Repairing Deep Cut Damage

For small-area damage, the following procedures are adopted:

- Cut off the outer rubber around the damaged area at approximately 45°.
- Buff the cut surface, then clean and dry it.
- Apply cement two times to the cut surface, the second coat applied after the first coat has dried.
- Apply cement to a piece or several pieces of filler rubber and then patch the filler rubber onto the cut surface after the cement has dried.
- Apply cement to a piece of reinforced fabric and patch it onto the filler rubber after the cement dries.6.
- Level the applied piece of reinforced fabric by rolling it with a grinder.
- Repeat steps 4, 5, and 6 until the last piece of reinforced fabric covers the outer surface of the dam body.
- Patch the outer surface of the damaged area with a piece of reinforced fabric.
- Carry out an air leakage test

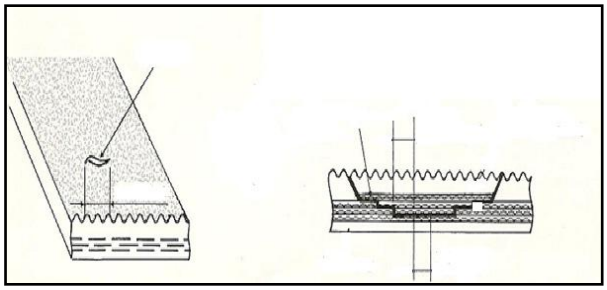

Figure 4- Repairing Deep Cut Damage

V. PROSPECT OF RUBBER DAM

- **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. 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.

- **Rubber Dam for Irrigation**

Rubber dam being deflatable to open the full passage way of the river channel during monsoon floods are ideally feasible water conservation structures for many small and medium rivers and will thus play a vital role in enhancement

Figure 5- Inflated Rubber Dam in Irrigation Canal

- **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's 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.

- **Rubber Dam in Watershed**

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 then 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.

VI. COMPARATIVE ANALYSIS BETWEEN CONVENTIONAL DAM AND RUBBER DAM

Cost Aspect: Replacement of heavy gates, hoisting gears and piers of conventional structures by light rubber-nylon shell body save huge amount of steel, cement, timber and other construction materials. Hence rubber dams could be economical.

Flexibility Of Operation: Rubber 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 dams.

More Water Inflow: 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 and facilitates the release of flood flow at a quicker rate when compared to conventional dams.

Installation: Installation process is very quick, as it done mostly by manual or remote sensors. It mainly consists of inflating and deflating as and when needed based on operating principles.

Silt and Sedimentation Removal: When the dam is deflated it facilitates free flow of water over it, without allowing the silt to deposit along the length of the dam and hence the effective storage and life can be increased

Water Tightness: The material used for rubber dam installation is totally watertight. So there is no problem of water leakage and excess flow of water from the dam.
Capital Cost: Total investment cost can be reduced to 30-40% than that of conventional gated dams.

Environmental Considerations: The installation technique helps in reducing the risk of disasters like bank erosion and the water flow also will not be disturbed in the process.

Transportation Convenience: They can be easily replaced and transported anywhere when needed due to lightweight nature of material.

Impact of Soil: Load of dam body is evenly distributed on foundation. This reduces considerably the treatment of foundation soil.

VII. ADVANTAGES AND DISADVANTAGES OF RUBBER DAM

Advantages

- Rubber dams with long spans (> 100 m) can be installed without piers.
- Rubber dams can be installed on virtually any side slope
- Rubber dams require only light foundations, leading to considerable savings in time and cost
- Rubber dams have lower maintenance cost.
- The flexible structure of the rubber dam virtually eliminates the influence of downstream dirt and sediment

Disadvantages

- The initial capital cost for installing rubber dams may be higher than other alternatives.
- The vibration of the dam body can cause premature failure of the dam due to abrasion effects.
- The rubber dam can get damaged during deflation
- Repair to dam bags is done only in dry condition. Underwater repair is not possible.
- Service life of dam bags is about 20 years. Replacement of the dam bag is needed if design period required for dam is longer.
- Cannot be used in large dams, only can be used as diversion weirs.

VIII. CONCLUSION

Rubber dam gives a major advantage in the flexibility of its operation. It can also be used as a temporary dam for the construction of conventional dams because of its transportation convenience. As we know that the overall cost and maintenance of Rubber Dam is low compare to other dam, so we can use this types of dam. Compared with steel gates, the rubber dam becomes more cost-effective with the increase of the length of its spans. The rubber dam has been put into a wide scope of application (irrigation, water supply, power generation, flood control, environmental improvement, and recreation) due to its structural simplicity, being inflatable and deflatable, and proven reliability.

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References

[1] Joygopal Jena, " Rubber Dam and Its prospects," Proceedings of International Conference on Structure and Civil Engineering , November 2012.

[2] X.Q. Zhang, P.W.M. Tam and W. Zheng, "Construction Operation and Maintenance of Rubber Dams", Canadian Journal of Civil Engineering. 29:409-420, 2002.

[3] Paul W.M. Tam, "Application of inflatable dam technology-problems and counter measures" Canadian Journal of Civil Engineering, 25: 383-388, 1998.

[4] Saleh, A. F. M., and Mondal, M. S, "Performance evaluation of rubber dam projects of Bangladesh in irrigation development." Irrigation and Drainage, ICID, 50(3), 237-248, 2001.

[5] M. S. Khan, M. Eklimur Reza, and Md. M. Rahman, "Rubber Dams in Bangladesh Harness Surface Water for Farmers to Irrigate at Lesser Cost", Critical Transitions in Water and Environmental Resource Management, World Water Congress,2004.

[6] Tam, P. W. M, "Use of rubber dams for flood mitigation in Hong Kong." Journal of Irrigation and Drainage Engineering., ASCE, 123 (2), 73-78, March/April 1997.

[7] Chao Wang, Yamei Zhang, and Aibin Ma, "Investigation into the Fatigue Damage Process of Rubberized Concrete and Plain Concrete by AE Analysis", Journal of Materials in Civil Engineering, ASCE, 23 953-960, July 2011.

[8] Ali, N. A., Amos, A. D., and Roberts, M, "Use of ground rubber tires in portland cement concrete." Proc., Int. Conf. on Concrete, Thomas Telford Services, London, 379–390, 2001.