

**Research Article**

## **Evaluating the design, construction and use of rubber dams**

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### **ABSTRACT**

One of the newest materials in the construction of water structures in recent years, is the rubber material that is widely used in the construction of dams or short dams. In rubber dams, the remarkable flexibility of materials against external factors, compatible with the environment, simplicity of design, short time of building, safety and stability of these structures, such as rigid dams, simplicity and ease of use and ultimately reducing operating costs caused has been used in large and small water projects. Due to the limited information in the field of rubber dams, this article provides the possibility of rubber dams introducing, how to design, building and maintaining.

**Keywords:** rubber dams, hydraulic structures, dam body, concrete pads, flexibility.

### **1. INTRODUCTION**

Vast territories of Iran, possess basin and sub-basins in which that due to the extent of the country and diverse geographical and hydrological features, each has its own characteristics. In recent years, in these basins, many concrete dams and soils has built by spending heavy amount of money and long time of performance, but advancement of dam construction science and using new technology by the name of rubber dam, with minimal expenses, short time of performance and numerous applications, required thinking and fundamental studies on the issues and benefits of using this type of dam. In the following we come to investigate this type of dams and their

applications, according to the climatic conditions in Iran.

First thought of using rubber dams designed by Norman m. imbertson to provide water of Los Angeles city and by following that the first rubber dam in the world was built in 1958 in the United States on the Los Angeles River. Since then, the use of rubber dams in different world countries such as Japan, Germany, the Netherlands, France and other European countries, were studied, so that now there are more than 4,000 rubber dam in the world. Today rubber dams are known as Fabridam, Rubber Dam and inflatable dam.

Rubber dam is a rubber tube that is installed along the cross-section of the river and with full

and empty it by using the compressed air or water created as an obstacle with the desired height on the way of the river water. Feeder system in these dams guides the air or water as a filling material into the rubber tube. In times of flood, which is a low barrier height, through special ducts, filling material is driven out. With regard to the use and importance of the rubber dams Islamic Republic of Iran project studies the northern coast of the country began to build a rubber dam. Following these initial studies the first rubber dam of the country designed on the Babol River in Mazandaran city by the name of Babolsar rubber dam, put into operation in 1996.

## 2. The rubber dam building

One of the newest material, which is considered in recent years in different countries of the world to build a dam or weir is synthetic material rubber. Although the rubber used in the water industry in particular, but this does not have a long history in dam construction. Rubber dam is a rubber tube that is installed along the cross-section of the river and with full and empty it by using the compressed air or water created as an obstacle with the desired height on the way of the river water.

Power supplies in these dams guides the air or water as a filling material into the rubber tube. In times of flood, which is a low barrier height, filling material through special ducts, is driven out. The height in such a dam is about 2 to 4 meters. Also in rivers with a width of one kilometer by building concrete bases can convert the width of the river to the appropriate number of openings, and in each opening installed a rubber dam.

A rubber dam is composed of 3 main parts:

A.

The dam body: rubber dam's body, is from rubber and fiber amplifiers, which provides the necessary tensile strength to withstand water resources and produce into layers with the width 2 meters.

B.

The dam channel: to establish and connect more rubber body that can harness the forces applied to the tube, a concrete channel in the floor and two sloping concrete surface on 2 sides of the dam is required. This concrete channel must be able to well tolerate the forces from the bracing system.

C.

Control room: A space with built-in air compressor, connected by pipes to the dam and in fact the control center, is a box cause to control the use of every moment of flexibility and the drain membrane of rubber dam.

## 3. Kinds of rubber dams

The most common and popular classification of rubber dams based on the type of feeding fluid in the rubber tube. Accordingly the rubber dams are divided into two categories:

- Inflatable rubber dam
- Hydro rubber dam

According to over existing experience there are more advantages in inflatable rubber dam than hydro rubber dam that among them can be mentioned the following:

- Accessing to large amounts of air to inflate a rubber dam is easier than accessing to large volumes of water to fill rubber dams.
- Inflatable rubber dams require less time to fill and empty, so the inflatable rubber dam faster reaction is possible in front of different situations.
- Inflatable dams weight load on the concrete pad and foundation is less than hydro dams, which is very effective in reducing the force of the earthquake.
- Risk of corrosion and clogging in the air pipes is less.
- The cost of building inflatable rubber dams due to required ancillary facilities is less than hydro rubber dams.

However the effect and vibration in the body of inflatable rubber dams is remarkable in such

dams that must be considered in the design of its body. But in general, according to the mentioned items the construction of inflatable rubber dams has been detected more suitable than hydro rubber dams.

Given that the overflow of water from the dam crest cause to shake and vibration in order to prevent this issue they use Deflector or thrower in the body is used. Thrower by throwing water and create an aerated area under the thrower is preventing tremor.

The rubber dam can be divided into two categories:

- Rubber dams with thrower
- Rubber dams without thrower

#### **4. The use of rubber dams**

With regard to the mentioned importance nowadays the rubber dams are used in various water projects that some of them are mentioned below:

- divert water to open channels for irrigation
- Construction of rubber dams in order to increase the water level in reservoirs of constructed dams
- Use rubber dams as wide river dam and...

#### **5. The use of rubber dam according to watershed conditions**

In terms of watershed Iran can be divided into six parts:

- A) The Caspian Sea basin
- B) The Persian Gulf and Oman Sea basin
- C) The central basin
- D) Sarakhs basin
- E) Basin of Uromie
- F) Hamoonbasin

Among these basins, the Caspian Sea basin, Central and Persian Gulf and Oman Sea are wider and more important than other areas.

##### **5.1 Caspian Sea basin**

This area is high rainfall regions of the country and a favorable climate for agriculture. For this reason, the water and its efficient use, is the most important factor in economic prosperity of the region. Rubber dam due to the mentioned

reasons, is a very convenient and cost effective choice for the northern part of the country:

1. With regard to the lack of high-quality materials for the construction of dams in the north of the country and the need to transport the materials over long distances, using rubber dams in the satellites hills, has much lower costs.
2. Northern Province with a large branches and rivers that are often abandoned and wild, and the water is not properly restrained. However, if you use this important resource in an appropriate way, it can cause to watered the under cultivation lands of the region, rubber dam, as a diversion dam can raise the water levels of rivers and connecting it to the water guiding channels, by far the cost less than the construction of a concrete dam or embankment or less pumping energy consumption, cause to the transfer of water adjacent lands.
3. One of the dangers that we see every year in the north of the country, flooding the adjacent lands of the rivers as a result of the sudden rains and floods which caused great damages. Rubber dam by being capable of rapid depletion can supply water throughout the year and can also, pass the water easily during the floods and prevent the existing problems in structures such as embankment and concrete dams. The only risk in this case that could threaten the rubber membrane is the crashing of foliage and overflow products which may lead to rupture of the membrane.
4. Despite high rainfall in spring, autumn and winter in the northern part of the country, the discharge of the rivers were low in summer and sometimes the rivers are completely dry. And while the water demand for the use of land for wheat, oilseeds and vegetables in the summer, is more than all the seasons, as far as the lack or abundance

of water at this time of year has a determinative role in the import of products such as wheat, For this reason, building rubber dams on the river, by preventing waste of water can have an important role in the region's economy and its prosperity.

5. In recent years, the proliferation of aquaculture in the country take much attention and the northern part of Iran by having multiple species and the presence of rivers and tributaries of the river is well positioned, However, due to lack of basic studies, unfortunately every year in some rivers in the summer and by drying the river water, we saw the death of many aquatics. One of the appropriate measures can be made in this regard, is Using rubber dam as a reservoir for the laying and maintenance of their fish is quite obvious that due to the low cost of construction and maintenance of dams Even in defeat this type of aquaculture projects, far less damage caused than by the clauses of the said projects to concrete and embankment dams. In addition, building rubber dam has destructive impact on environment and the river regime is less changed.
6. Due to the flexibility in rubber can use them temporarily as the upstream cofferdam (cuffer dam) to divert river water during dam's construction. Considering that upstream cofferdam may be destroyed after the completion of the main dam and used as dam sediment, the use of rubber dam in this case can be quite justified is due to the limited depth of sediment accumulated in the reservoir dams can designed the rubber dams in a way to be submerged, which excludes a major part of the sediment to the main reservoir.

As a specific example of the use of rubber dams for this purpose, we can name sefidrood dam by reservoir project. Sefidrood Dam, is such dams that sediment issue is significantly make

problems for optimal utilization of existing water facilities in the dam. This trend has caused sedimentation tank during operation of 36 years of dams lost about half of its useful capacity. Several different methods have been proposed to save the crisis, including opening the gates of deep discharge, and watershed management practices and sediment storage dams upstream of the dam. [6, 7] A recent project in cooperation with the University of Gilan, and Gilan Regional Water Authority is being studied, including the construction of an embankment dam with a capacity of approximately 150 thousand cubic meters in the upper sefidrood River to raise the water level and eventually lead diversion channel by entrance barrier deep discharge, to remove sediment from the tank as well as a reservoir downstream of the outlet channels. However, if it can be used rubber dam instead of using embankment dam, according to the required height can spend with confidence and with less maintenance costs, eligible deposits provide a diversion channel. It is necessary to note that after making the penetration of water through the dam body and the foundation has been apparent in the area and the basic measures needed for sealing damaged areas or risk that these problems can be easily overcome rubber dam.

## 5.2 Persian Gulf and Oman Sea basin

Existing of 2 coastal strip of north and one in the south, has created a unique situation in Iran. The main feature of the southern part of the country, the interference of fresh and saline water, poor soil, lack of water most days of the year, the low base flow and highevaporation from reservoirs. Then begin the functional aspects of the rubber dams in this part of the country.

- A) in the southern part of the country, the interference of fresh and saline waters cause the inappropriate cultivation conditions, while if we can separate fresh water from salt water, many lands can be cultivated in

south of the country. Rubber dam, as a diversion dam with a capacity for discharging and filling, can prevent the loss of fresh water and its interaction with branches running parallel, and it is stored for using in agriculture.

- B) One of the problems in south of the country is lack of fresh water used for drinking and public. Due to the lack of rainfall in this regions and the low level of groundwater level and thus the low base flow of rivers, can provide the possibility of water storage and feeding aquifers by storing the water in water full days. Meanwhile, when the need is required the water be directed to the channel or the other branches running, the water level can be easily passed by incubating the river.
- C) Shrimp is from the last few years of government policies and for this purpose the southern coast of the country has the most favorable conditions. Construction of concrete and embankment dams with heavy expenses and environmental impact, are not a good choice and while the rubber dam with minimal cost and short time duration of performance can develop shrimp accelerate.

**5.3 Central river basin**

Freshwater, can benefit from the proximity to the sea, the central region of the country is deprived of sufficient water so that the water supply is the main purpose of the dam. For this reason, this part of the country's dams and large reservoirs designed primarily with high altitude are provided to allow maximum storage of water. Rubber dam as cheap instruments that can be raised to a height of 10 meters, the dam is the best way to increase the free height, meanwhile, during floods or necessary times, by emptying the air of tube can also be used as a slope.

Therefore, the use of rubber dam in central areas of the country, has a significant impact on reducing costs of dam building and increasing the volume of reservoir in the future.

**6. Rubber dams built in the world**

Rubber dam construction techniques return to the time when the first rubber dam was built in 1958 on the river of Los Angeles. The dam is proposed by Norman Emerson who is responsible for the operation of the utilities areas built in the city of Los Angeles. Given that to guide the water to the land around the river Steel lakes was used as well as the delay in opening and closing the valve, the valve Emerson alternative presented with a rubber dam. Despite enough knowledge in the design area, construction and operation of rubber and generalizing knowledge of constructing these dams, many countries are currently encouraged to develop and use them.

**Table 1.** Sample rubber dams built in other countries

Rubber dam name	location	Date	Purpose
Vaca	Philippines	1983	Irrigation
Mirini	Australia	1986	Irrigation
Susquehana	America	1988	Irrigation
Tsuda	Japan	1988	Irrigation
Alamedreek	America	1989	Irrigation
TKL12	Hong Kong	1997	Irrigation

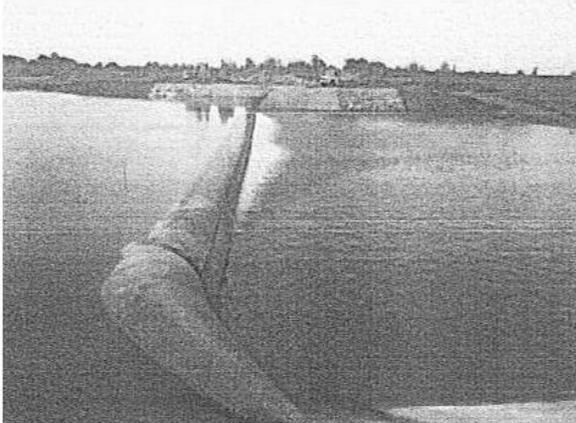
**7. The rubber dam in Iran**

Although the use of rubber in rubber dams construction is short-lived, but constructing thousands of rubber dam with different purposes in other parts of the world highlights this fact that it has its place among different materials and every day we see more and more use of this innovation.

Because of the importance of this subject, the energy ministry of the Islamic republic of Iran, by collaboration with the Chinese water Ministry, begin the study of rubber dams in Mazandaran, Gilan and Golestan. Following these studies, Iran's first rubber dam was built in the year of 1375, as Babolsar rubber dam, on Babolsar rood in Mazandaran. Babolsar rubber dam profile is as follows:

- Height: 1.3 m
- Body length: 60 meters

- Dam Type: Inflatable (automatic control system)



**Figure1.** Babolsar rubber dam on the BabolRiver

The main purpose of constructing this dam can be cited as follows:

- To avoid interfering Caspian Sea salt water in tide condition with the Babol river.
- Use the discharge of the river for agriculture
- reduce earthquake hazards due to the presence of numerous faults in the area.

In the coastal fringe of the Caspian Sea due to good rainfall numerous rivers with large and small tributaries that flow into the sea after a short distance. However, given that the level of agricultural land in the region is higher than the level of the river and the construction of rigid structures are incompatible with flood flows, the use of rubber dams in this area seems very suitable. In the follow of Babolsar rubber dam construction they begin to identify the suitable stage of rubber dam in Caspian Sea.

Using rubber dams in southern areas and on the beach can have beneficial effects, some of which are mentioned below:

- To avoid interfering saltwater with freshwater.
- Use rubber dam for storing base flow of rivers and development of cultivation.
- Use rubber dam for aquaculture in coastal seas.

### **8. The process of making rubber dams**

Rubber dam construction will be done in three stages:

- The design stage
- Construction stage
- The maintenance and operation stage

Fortunately, in the first stage that is related to the rubber dam design, there is no problem in our country. Hydraulic and structural design calculations based on the common standards in the world are done by internal experts. In construction stage the only problem is rubber dam body building that certainly the technique of making this type of rubber with a slight change in tire production lines of companies in our country is possible. According to the mentioned content it seems that our country will be able to take advantages in development of water resources like other countries with building rubber dam

### **9. Benefits of rubber dam**

- flood control and regulating river flow
- Control of river sediment
- Temporary storage of the base flow of the river
- Separation of fresh and salt water
- Increase the storage capacity of dams
- replace with steel valves
- Shrimp
- provide tourism and recreational areas for swimming and sailing
- Feeding the underground aquifers
- Use a rubber dams as cuffer dam

### **10. The use of rubber dams**

- Dam control and coastal protection against erosion
- Mounting on dams and reservoirs in order to increase their height and help to produce electricity
- Reduce water pollution
- Increase the storage capacity of dams
- Entertainment, such as swimming, boating...
- Prevent the intrusion of salt water into the beach in tide condition and...

### **11. Rubber dams economic benefits toward other types of dams**

Including economic advantages compared to concrete dams and embankment dams are mentioned below. As follows:

- These dams are requiring minimal maintenance. The bulk of repairs is related to the dam's mechanical systems. Repair and maintenance of tires is very similar to the dam and in case of
- Against the concrete and embankment dams that are required a very detailed Geotechnical studies for implementing dam body, rubber dams due to their very small forces into the foundation, have simple foundations that are practicable in low-resistance and clay lands, and in general do not need complex foundations.
- rubber dam at the crater up to 150 meters runs, and unlike gated dams, that each 15 to 20 meters needs a base to install the valve, do not need a base.
- Due to the flexibility of rubber as the main material of dam in an earthquake time implement reactionary and prevents breaking dam and overflow of flood to the downstream.
- Better performance discharging dam, toward the lakes and concrete dams and embankment dams
- Ability to run on high gradient and lack of strong side support.
- A reduction in execution time compared to other types of dams.
- Reducing negative environmental effects.
- Reduce the disturbance regime of rivers.
- Due to the possibility of changing the height of the rubber dams and their adaptation in different conditions of flood and drought is more than other types of dams.
- Requires less manpower to run and required less qualified workforce.
- Need to less maintain and little control, after running the operating system due to its simplicity.
- Reduce the risk of drowning adjacent lands toward the rigid structures of concrete or embankment.
- Lower cost and quick implementation

## 12. Implementation of rubber dams

Rubber dams is formed of an air tube that is connected to a substrate, Older types of rubber dams was called FABRI DAM in which a mixture of water and air for inflating the tubes were used, now they use dams by the name of INFLATABLE DAM dams, that are defined as inflatable.

Rubber dam building can be consist of three parts:

- Dam (RUBBER DAM BODY)
- The dam and containment equipment
- control system and operation

## 13. Some of the difficulties of rubber dams

- Damage to the dam when deflate the body
- Dealing large and sharp objects that cause damage to the body.
- Escape and air exit: When deflate the dam may sharp objects create puncture and also in floods time the dam hit by large objects such as logs and ... scratches or holes are created on dam.

## 14. Conclusion

The result is that due to the resilience of these structures can be dangerous to use it in areas with faults due to large reductions, reduce the earthquake force and in the event of an earthquake with the help of much flexibility prevent breaking the dam and sudden influx of the flood to downstream. Moreover, according to the change of dam height, this structure is more adopted with the conditions of drought and flood periods.

Due to extensive applications and multi-purpose of dams, and also the cited advantages, with respect to the construction and maintenance of this type of dams do not required many experts and complex technology, In the case of fundamental research, due to the available facilities and expertise in the country, we can use this technology sufficiently in a recent half-century. In the country of Iran with different climatic characteristics and the characteristics that noted, in many cases rubber dams can be a

good alternative to embankment dams and concrete dams. It is hoped that further studies should be done in this regard. At the end the followings are recommended.

1. In the basin of the Caspian Sea due to the reasons such as lack of good quality material, lack of proper containment of rivers, flooding the surrounding land during flood filling the reservoir of sediment and lack of water in the cultivation season, the rubber dam is completely justified.
2. In the Persian Gulf and Oman Sea basin because of saltwater and the interference of fresh and saline water and also suitable shrimp, rubber dam is an excellent choice and
3. Because the body's central desert basin, water shortage and low base flow, the use of rubber dams to increase storage dams and increased free height due to its low cost, is recommended.

sediments from the reservoir through erosion so early, the sixth International Conference of Civil Engineering, 112, Isfahan, 2003

9. Anwar , H.O. , ( 1967 ) , " Inflatable Dam " J. of Hydraulic Division , ASCE , Vol. 93 , No.HY3.
10. Chanson, H., (1996), "Some Hydraulic Aspects during Overflow above Inflatable Flexible Membrane Dam." Report CH47/96 Dept of Civil Engineering University of Queensland, Australia.
11. Chanson , H. , ( 1998 ) , " Hydraulic of Rubber Dam Overflow " , Dept. of Civil Engineering University of Queensland , Australia.
12. Bridgestone corporation, Rubber Dam Design & Features, (2002)
13. USBR, Design of Small Dams. (1974)
14. Rubber Dams in coxs Bazar, Bangladesh, Network Web Hosting Company

## 15. LIST OF REFERENCES

1. Islami, Farzad. (2001), "rubber dam", the eighth seminar of Civilengineering student, martyr Chamran University
2. Mazandaran Regional Water Authority (2002), "A rubber dam Babolsar" Mazandaran
3. Shamsaie, A., (1998), "Rubber dams and their comparison with other options," Proceedings of the Faculty of Civil Engineering, Sharif University, Tehran, Iran
4. BaherTalari, Tahir andAli Ghorbani, Morteza. Dam Engineering
5. Lar Consuling Engineers, Rubber Dam and Its Application in Water Resources Engineering
6. Classification of Watersheds, Water Resources of Iran
7. Watersheds and Rivers of Iran, Water Resources of Iran
8. LashteNashaie, Mir Ahmad andMehrdad, Abdolhamid and Firoozfar, Alireza,