

Comparison of rubber dams with concrete and earth dams in terms of quality, mode and execution time

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Abstract: Since water supply is always a basic human need, flood control and current water through the construction of the dam are essential and basic infrastructure for achieving economic self-sufficiency and is of particular importance. The role of water structures in quantitative and qualitative improvements in human life is so important that today in each country, significant contribution has allocated to the development of human resources and the budget.

One of the most recent materials used in the construction of water structures over the last few years is the rubber material that is widely used in the construction of short dams.

The rubber dam is made up of high-tensile resistance rubber sheets, which swells with air blowing or entering the water into it, like a large tube, and is as obstacle in front of the water and whenever the fluid is removed from the inside of the two layers of rubber, it is placed in the form of a floor covering in the river bed and the natural flow of the river is resumed.

In rubber dams, considerable flexibility of materials against external factors, harmony and compatibility with the environment, design simplicity, short-term construction, safety and durability of such dams compared to rigid structures, led to simplicity and ease of operation and ultimately reduced Execution costs to use at small and large hydraulic designs, including the use of rubber dams rather than short dams.

In this research, the main question is whether the construction of rubber dams compared to earth and concrete dams in the country is economical? And the main hypothesis is that the construction of rubber dams compared to earth and concrete dams in the country is economical. Independent variable is here to manage the construction of rubber dams in the country, and dependent variables are earth and concrete dams.

Keywords: dam, rubber dam, earth dams, concrete dams, construction management

Introduction

Since water supply is always a basic human need, flood control and current water through the construction of the dam are essential and basic infrastructure for achieving economic self-sufficiency.

One of the most recent materials used in the construction of water structures over the last few years is the rubber material that is widely used in the construction of short dams.

Generally speaking, in a hydraulic structure, it is expected to carry out a particular task, but this does not mean that only a unique plan can do this, and there can be some placement in these designs. One example is the use of rubber dams instead of short dams¹.

Damming history

Dam construction industry has always been considered by different societies as one of the oldest and most sophisticated construction activities and economically as one of the most important economic resources of every country and region. Damming has always been considered as one of the most important engineering activities, so residents of different regions, based on the

geographical conditions, have made the necessities for the construction of dams with different specifications.

The history of dams in Iran, Egypt and Mesopotamia has a long history, and still signs can be found in these lands. In general, damming, as well as dredging and restoration historically in Iran and other territories, like other public works and large projects, were usually carried out by the governments and kings who were interested in the prosperity and development of the provinces. The economic prosperity and the progress of the villages and towns associated with irrigation and water systems also depended heavily on the dam and the importance of the rulers on these issues².

History of the use of rubber dams

The use of rubber materials in aqueous plans has long been widespread, and the most important use of rubber are the sealing of aqueous structures, but rubber dams as a further application of this synthetic material are currently widely used in the world. Rubber dams are a relatively new technology used to control surface water.

About 40 years have passed since the first rubber dam was built on the Los Angeles River in the

¹ Shahrokhi, Mojtaba, Iran Technology Website, January 6, 2009.

² Ibn Balkhi, Fars Name to Ali Nagi Behroozi's Quest, Fars News Union Press, p. 4

United States to provide part of the city's water¹. By 1985, steel gates and wooden boards in the Los Angeles River were used to direct water to vast areas and waterways, which were in front of the gates to allow water to flow more pressure².

Rubber dams built in Iran

It is possible to implement rubber dam designs in the country, including the northern, southern and central parts of the country. In fact, in the early studies on the northern coast, more than 200 rubber dam designs can be implemented. However, due to various issues such as environmental protection, ecological status improvement, artificial nutrition plans, shrimp breeding, etc., a considerable number of rubber dam designs can be applied on the coastal margins of the Oman Sea and Persian Gulf.

Some other rubber dams in our country:

- Arabkhail Rubber Dam, installed in 2004 - length of 45.5 meters- height of 3 meters.
- Armich Kola Rubber Dam, installed in 2005 – length of 50.5 meters – height of 35 meters
- Miandasht Rubber Dam, installed in 1996 - length of 70 meters – height of 2.80 meters³

General objectives of rubber dams

- Temporary storage of the base flow of rivers for agricultural water supply
- Increasing the water level in the river and reducing the cost of pumping water in agricultural lands in these rivers
- Isolation of contaminated or salty water from fresh water
- Use rubber dams to increase the volume of large dams' storage.
- Use of rubber tubes instead of steel gates in dams.
- Reduced erosion in steep rivers.
- Improve the environmental, biological and ecological conditions of the project area.
- Use of rubber dams as diversion dams to agricultural water supply.

Advantages of using rubber dams

- One of the important issues in the use of rubber instead of other materials is the adaptation of their performance with nature.

- Execution costs for rubber dam plans are far lower than the implementation of the plan with other materials.
- The design time in such systems is very low compared to other structures.
- The duration of the construction of rubber structures is short and fast.
- The parameters required for design in such structures are small and easy to access, and even in some cases, judging and guessing and engineering estimation is sufficient.
- These rubber structures are applicable in all weather conditions and in the event that even the substructure is inappropriate and that it is not possible to construct other structures or materials in the area.
- The design and implementation of rubber dams does not have any particular complexity⁴

Types of rubber dams

Typically, a rubber dam consisting of a massive and large tube is classified in a variety of ways, including:

- 1 - Rubber dams with fins
- 2 - Rubber dams without fins

In a rubber dams with a deflector fins, the wing-shaped appendage in the crest arch is considered in the lower part of the body, preventing water contact with the lower part of the rubber during the pass of the flow⁵.

In a rubber dams without fins on the parabola-shaped outer surface, rubber tube is in contact with water and there is no appendage or fin.

Environmental issues of rubber dams

Environmental Issues and Problems of these construction projects are negligible due to their small size, and these effects include interactions between the environment on the dam and rubber dam on the environment, which themselves are divided into two groups, beneficial and harmful effects. But what's debatable about this is the inappropriate effect of the environment on the rubber dam and vice versa. Because any dam or construction plan is intended to achieve goals that are likely to address economic and social issues and are created to achieve social economic outcomes.

In general, the environmental factors affecting rubber dams can be summarized as follows:

Environmental effect on rubber dam

Temperature

¹ Varjand, Parviz, ancient castle of Izadkhad and its historical effects, historical surveys No. 1, seventh year

² Safari, Majid, rubber dams, a graduate student in Civil Engineering, Sharif Civil Publication, No. 23, autumn 1998.

³ Mehdi, Hafarezade Azar, Rubber Dams, Road and Building Magazine, Islamic Azad University, Maragheh Branch, December 2004.

⁴ www.IrPDF.com

⁵ Safari, Majid, rubber dams, a graduate student in Civil Engineering, Sharif Civil Publication, No. 23, autumn 1998.

One of the definitive factors in the performance of rubber dams is the ambient temperature, although the rubber can function at very cold or hot temperatures (-60 to 50 ° C). But it should not be forgotten that as the rubber dam acts as a hydraulic structure, the water temperature adjacent to the dam is also function of the ambient temperature, which can create frostbite water and ice blades that in constant contact with the rubber and or passing over the rubber will gradually cause abrasion.

The effect of floods

In contrast to dams that are made of rigid materials, the shape of rubber dams are changed when the flood occurs, and are slept the river bed, and therefore the flow of river floods is much more appropriate than rigid structures. In fact, during the flood, all of the dam's components are flooded at the site of the dam.

Sometimes flooding of river path and adjoining terraces causes to flood the room and the access road, and therefore, by hydrological survey of the river, it is necessary to prevent flooding the control room by building appropriate structures such as coastal walls, building proper foundation for the facility, and selecting a level surface above the danger zone of the river.

Water pollution

Fortunately, chemical pollution and the presence of solutes in rivers and seawater do not have any effect on the life of the rubber and will not cause any reaction.

The effects of human activity

Human activities such as hunting, planting, traffic, fires, sharp objects or shooting errors and traffic accidents and sabotage may pierce the dam's rubber and make it difficult.

Effect of rubber dam on the environment

Typically, a rubber dam can also affect the environment, and these effects can be considered from various aspects, including:

- 1 - Rubber dam and its incompatibility with the nature of alluvium and river
- 2- Economic and social effects of rubber dam design¹

Life and durability of rubber dams

In hydraulic structures, the design is related to the life and durability of the materials used, and as the material life or durability is high and the

probability of destruction is low, the share of the imposed costs in the project period is reduced and, as a result, the economic benefits of the plan increase. Rubber dams are fully and robust to environmental factors such as water, oxygen, pollutants, saline and alkaline water, toxic waste and acids. Even from a mechanical point of view, ordinary sharp objects, foliage, ice fragments and ordinary rocks can not damage to dam rubber, and the durability of rubber is high.

These characteristics, as well as the history of the construction and operation of such dams in different countries of the world, show that the life of these dams is easily more than about 30-40 years. Due to the fact that the economical life of small hydraulic structures is about the same, the type of rubber materials in the category and group of materials is considered durable and enduring.

It should be noted that the poor operation of the rubber dam can reduce the life of these dams. In the countries where precautions are taken and qualified personnel are used to maintain and repair rubber dams, the life of such dams is very long and in countries that do not care much about the operation, usually the life of rubber dams is short, and even in some cases, the period of exploitation ends up in a season².

Design steps in rubber dams

In general, the main steps in the design of rubber dams can be summarized as follows:

- Access Road Plan
- Deviation System Plan
- Dam Framework Plan
- Design of related structures
- Control System Plan

But from another point of view, these study steps can be categorized in the form of calculations as follows:

- Studies on rubber body.
- Hydraulic studies and design.
- Structural studies and design
- Control System Studies and design

Although, according to consultant engineers, the design of rubber dams is done in accordance with the first type with separate study teams, but because some of the studies and designs related to rubber dams are similar to other designs, it is not necessary to repeat these descriptions and design of the rubber dam is to be carried out in conjunction with Hydraulic, structural and control system selection studies.

Rubber dam body design

¹ see, H.B et al, (1985), seismic design of concrete faced rockfill dam, concrete face rockfill dams-design, construction and performance, JB. cooke and J.I sherard , Eds, ASCE, Detroit prvs-478

² Galtani, little by little, translate by Shahrzad, hydraulic plant and general terms of printing, Khuzestan Water and Power Organization, p. 12.

The body design is considered to be the most important part of the rubber dam design. Usually, the following factors must be determined and calculated in the rubber dam design.

- Select dam type
- Check the type of rubber
- Calculation of tensions
- Determine the thickness of the rubber
- Determine the dimensions of the rubber¹

Dam type

Typically, dam type are selected between two types of pneumatic and aqueous rubber, according to considerations such as design goals, river flow deviation, the use of a rubber tube to increase the height of dams, create a suction pond for pumping, shipping, river structures and storage, rubber type and its cost.

Types of rubber

EPDM or EPM rubber is used in rubber dams, and until the emergence of new innovations exclusively, one of the two types of rubber is chosen. At present, more than 70% of rubber dams are made from EPM type, but the choice of EPDM-type rubber are related to its available and cost. It should not be forgotten that the choice of type of rubber is related to the rubber industry of the consumer country.

Hydraulic design of rubber dams

In rubber dams, the design of structures involves the solving of hydraulic problems. Hydraulic factors related to such designs are:

- Hydraulic inspection of rubber dam overflow and its calculations
- Determine the rising pressure value
- Calculate the leakage of below of foundation or concrete padstone and;
- Inlet and outlet pipes or rubber damp drain

Earth dams

Earth Dam is one of the oldest construction facilities that human beings have been creating due to its basic needs for agricultural operations and water supply.

The earliest earth dams that even today can be found in most parts of Iran are small or large dams that are built with the primary equipment, such as spade and hack on the irrigation route.

History and statistics of earth dams constructed in Iran and the world

¹ New mark, N. (1985). effect of earthquakes on dams and embankments geotechnique, vol. 15. no. 2 . london england

The history of making the first earth dams in the world dates back to the time of early civilization, when humanity chose agriculture as the main method of production. One of the first examples of ancient dams is the sadd-el-katara earth dam that was built in Egypt about 4800 years ago².

In Iran, the history of building earth dams in different shapes and dimensions is back to the past. Considering the climatic conditions of Iran, the use of earth and rock dams for the storage or diversion of water is quite common, so now some of the works of these types of dams can be seen in different parts of the country. For example, the works of the earth dams of the Abshineh area of Hamedan, the old Gorgan dam (Garkaz dam), Mazandaran Bandsaars and etc can be pointed out³.

Requirements for the selection of earth dams

In general, the earth dam should be constructed where has been shown to be preferable to concrete dams. Generally until now, the following is the conditions that earth dam is preferable to concrete dam and its choice has been preferred:

- A) In areas where the valley is very wide.
 - B) In areas where there is no solid and suitable abutment foundation for the transfer of forces on the concrete dams' body (loose lands and weak to resistance).
 - C) In areas where appropriate soil materials are available at a reasonable and affordable price.
 - D) In areas where cement and other concrete materials are very expensive and out of reach.
- In terms of quantity and quality of materials used, earth dams are divided into three groups as follows.
- Homogeneous earth dams
 - zoned earth dams
 - Rockfill dams with impervious membrancers or membrane earth dams⁴

Types of concrete dams:

- 1- Gravity Concrete dams
- 2- Buttress Concrete Dams
- 3- Arch Concrete dams
- 4 - rolled Concrete dams⁵

Gravity Concrete dams

A Gravity dam is a heavy structure made of concrete or building materials that are built up

² ICOLD (1998). world register of dams, international commission on large dams, paris

³ Rahimi, Hassan, Earth Dams, University of Tehran, pp. 39-40

⁴ Baher, Tladari, Taher, Ghorbani, Morteza Ali, Dam construction principles, baghe Andisheh, 2001, p. 29

⁵ Noushad, Soheil, Said, cracks in concrete dams, Ministry of Energy, pp. 28-30

across the river in order to increase the volume and height of water at its upstream, and its shape and design are such that it is sufficient for the stability of the structure against the forces imposed¹.

Buttress dams

Buttress dam is a barrier structure against water, where the water pressure, ice cover-induced force and other forces applied are tolerated by a slab in the upstream, and thereby forces first is transferred to the Buttress, and Then it to the foundation.

Among the well-known buttress dams, the first dam was built in Spain in the 16th century by the name Elche, which is 23 meters high and consists of rocky materials with arched openings (between bases)².

Arc dams

The arch dams are curved in the plan so that the curvature is directed to the upstream. These dams, which are very suitable for thinning valleys, generally most of the forces on the dam transfer to the flanks and a small part of them to the bottom of the river bed.

Among the concrete dams, arch dams are of particular delicacy and sensitivity and according to their design, calculation and execution; they also have their own characteristics³.

Rolled concrete dams

Rolled concrete dams or R.C.C. are concrete dams that have been used since the 1970s as a new method for the construction of concrete dams. This method can also be used to rebuild existing dams.

By definition, rolled concrete or R.C.C is zero slump concrete and earthworks machines are used to transport, distribute and density⁴.

Comparative study of the advantages of rubber dams with earth and concrete dams

1. Fast construction

- Continuous and mechanized construction of similar but less voluminous earth dams
- Ability to delete or diminish the dimensions of the tunnel
- Lower heat control due to less cement

¹ Ghaemian, Mohsen, Ardakaniyan, Reza, Instrumentation and Measurement of Concrete Dams, Ministry of Energy, 2005, pp. 3-4

² Short dams, damming unit, construction Jihad, East Azarbaijan, pp. 18-35

³ Nikoo, Turan, dam construction principles, library and technical documentation center, consulting company in water, p. 20

⁴ Niaharan, Mohammad Esmaeel, Introduction to Roller Concrete Dams, Consultant Engineers in Water, Ministry of Energy, p.131

- The possibility of building moderate dams (with a volume of 250,000 cubic meters) for about six months

- Extensive work environment and more safety
- Decrease formatting

2 - Fewer costs and more benefits

- Mechanized construction
- The availability of the necessary machinery
- Less need for expert worker
- Lower cement
- Reduced thermal control and the possibility of using pozzolan
- Possibility to use materials that can not be used in ordinary concrete
- Decrease formatting
- Low cost deviation system
- Quick construction

3. Resistance to flood overflow from the body

- Ability to delete or diminish the dimensions of the tunnel
- Less design
- The possibility of a step weir and a faster dam construction
- Ability to reduce overflow dimensions by taking into account the volume of flood control
- Resistance to earth dams against overflow
- The advantages of rolled concrete dams⁵

Rubber dam

- One of the important issues in the use of rubber instead of other materials is the adaptation of their performance with nature.

- Execution costs for rubber dam plans are far lower than the implementation of the plan with other materials.

- The design time in such systems is very low compared to other structures.

- The duration of the construction of rubber structures is short and fast.

- The parameters required for design in such structures are small and easy to access, and even in some cases, judging and guessing and engineering estimation is sufficient.

- These rubber structures are applicable in all weather conditions and in the event that even the substructure is inappropriate and that it is not possible to construct other structures or materials in the area.

- The design and implementation of rubber dams does not have any particular complexity

- Due to lower cost, it is possible to use the financial power of people to build such dams.

⁵ Imami, Kamran, Construction of Concrete Rolled Dams in Iran, Scientific Meeting Specialized Introduction to Concrete Rolled Dams, Technical Documentation Center of Water Consulting Engineer

- Ease of operation and reduce the costs of operation and maintenance, are the main advantages of these structures.

Conclusion

Construction of the dams and water structures are essential and basic infrastructure for achieving economic self-sufficiency and is of particular importance. The role of water structures in quantitative and qualitative improvements in human life is so important that today in each country, significant contribution has allocated to the development of human resources and the budget.

Designing such structures, the safety and durability of the structure, the speed and ease of construction, environmental compatibility, durability and cost of the project are among the important issues that are always the minds of the designers involved. Therefore, it is tried to obtain the maximum confidence coefficient for the above problems by using new technologies and utilizing various tools and materials.

One of the most recent materials used in the construction of water structures over the last few years is the rubber material that is widely used in the construction of short dams. In rubber dams, considerable flexibility of materials against external factors, harmony and compatibility with the environment, design simplicity, short-term construction, safety and durability of such dams compared to rigid structures, led to simplicity and ease of operation and ultimately reduced Execution costs to use at small and large hydraulic designs, including the use of rubber dams rather than short dams.

As noted, rubber dams have obtained a proper engineering solution for diversion, storage and adjustment of river water. This structure is an alternative to concrete structures with metal gates. With this technology, the scale of construction works is reduced to a normal project and unnecessary mechanical equipment is eliminated.

As a result, operating and maintenance costs, as well as running time, diminish dramatically. But the advantages of this technology are to fine-tune the digital and automatic water discharge through the rise of these dams height. In fact, rubber dams can be adjusted with tuning of air amount within them and, if necessary, can easily be moved.

But the advantages of this technology are to fine-tune the digital and automatic water level through the high rise of these dams. In fact, rubber dams can be adjusted with a small amount of air within them and, if necessary, can easily be moved.

Currently in a large number of water projects, the rubber dam are used to diversion of river water, prevent fresh and salt water interference, tide

control on the coast, increase the volume of dams constructed and in designs such as artificial nutrition, environmental improvement, Hydropower production, rising water level in rivers for shipping, or energy saving for water pump and improve river banks.

Taking into account the above, the possibility of using rubber material in the country's water plans will not only save economies, but also some structural and hydraulic problems will be eliminated and plans will be implemented quickly.

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