Journal of Water Sciences & Environment Technologies

Cit this: *JOWSET, **2017** (02), N°01, 106-110*

Finding Rubber Dam Installation Site on the Karoon River, Between Molasani and Ahvaz (Iran)

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As the supply water for agricultural, industrial and domestic purposes has always been a basic human need, controlling floods and flowing waters through by constructing dams is an essential and fundamental issue in achieving economic self-sufficiency. In this paper, suitable locations for rubber dam installation have been studied along the Karoon River between Ahvaz and Molasani, Iran. Rubber dams are hydraulic structures that can be inflated or deflated to suit circumstances. Potential rubber dam sites have been investigated for the temporary storage of river base discharge, reducing pumping costs to agricultural lands, and for water sports and recreation. The criteria for determining the appropriate installation sites include adequate river width at the location, and suitable river breadth, height and depth upstream. Thus, all locations in the study area which fitted these criteria were selected. Five such sites, at Molasani, Seyed Saleh, Gabir, Kut Abdullah, and Daghaghele Dam, respectively, were deemed potentially appropriate for rubber dam installation.

Received: 07 April 2017
Accepted: 22 May 2017
Available online: 30 May 2017

Keywords:
Karoon River
Molasani- Ahvaz
Rubber Dam Positioning

Introduction

Iran is located in an arid and semi-arid region. Surface flows are distributed unevenly, which causes major limitations in the optimum use of water. The bulk of the surface flows are also out of reach and flowing to the sea, before they can be used. In most cases, diversion and storage of river water is achieved using massive concrete structures equipped with heavy steel gates. Execution and exploitation of the dams' components involves considerable time and cost. Constructing such dams is not the only problem, the most important issue after implementation is sedimentation, resolving which requires very costly.

Electromechanical equipment Rubber dams can eliminate sedimentation, which causes many ecological and environmental problems. The introduction of this new technology to the water industry will bring considerable cost reductions; it can play an important role in future projects. The precise and automatic adjustment of water level elevation and water discharge rate raising the dam height is one of the technology's main advantages.

Rubber dams are inflated or deflated for adjustment, and can easily be moved, if necessary. So, in areas at The risk of

abnormal flooding, or exposed to seasonal and/or flash floods-occurring very suddenly and unexpectedly because of local intense storms, rubber dams are a good alternative to mass dams. During the flooding, when the pressure is increased and disturbs the pressure equilibrium inside the rubber tube, the dam deforms and rests on the concrete floor, allowing the passage of water without hindrance [1].

Extensive research has been conducted into the design and construction of rubber dams, in Iran and elsewhere. It is estimated that there are currently more than 4,000 rubber dams around the world, including about 100 in the United States, 1,000 in Japan, 300 in China, and hundreds in Europe – e.g., in Germany, Austria, Holland, France, England and Yugoslavia.

Iran's first rubber dam was installed in 1996 in Mazandaran Province (Iran), on the Caspian Sea border on the Babol River. Known as the Babol Rubber Dam, it was built by the Satujo Rubber Company. Its main purpose was to avoid the mixing of saline waters from the Caspian Sea with river water, so that the river's base discharge can be used to provide a water supply for the adjacent plains [2].

Bina and Ahmadi using earlier physical models and experimental data, studied different hydraulic and geometric parameters affecting the discharge coefficient of the rubber dam. Finally, to enable use to be made of these design studies, a variety of linear and nonlinear equations were derived and presented for estimating the discharge coefficient [3]. Hedayati et al examined the applications of rubber dams on the Tajan River, upstream of the Tajan Diversion Dam, in the north of Iran. They stated that the dam was installed to create a recreational and boating lake, and noted that the 20 or so other rubber dams under study show the rapid spread of construction of the concept [4]. Madadi and Yakhkeshy examined rubber dam applications, such as food and water flow control, avoiding water wastage, managing surface water storage and regulation, as well as use [5].

Hsieh and Plaut used two-dimensional linear vibration in rubber dams. Vibration modes and frequencies were calculated using the finite difference and boundary element methods. The effects of membrane density, and water height upstream and over the dam, on frequency and vibrations was determined [6]. Saleh and Mondel studied hydraulic, agricultural and economic factors in relation to two irrigation projects in Bangladesh. In these projects, the maintenance and operating of the rubber dams used to supply water were less than those of other options [7].

In this study, using hydrologic, hydraulic and other information, an attempt was made to determine the most appropriate rubber dam installation option on the Karoon River, from those available.

Materials and methods

The study area was the Karoon River originating Mount zagross in The south-west of Iran, and passing the cities of Ahvaz, Andimesk and shoshtar joining to Oman sea The Persian Gulf, between Ahvaz and Molasani. This section is about 90 km long and it lies between 48 degrees, 40 minutes and 48 degrees, 54 minutes longitude, and between 31 degrees, 19 minutes and 31 degrees, 36 minutes latitude. Fig.1 shows general location of the study area.

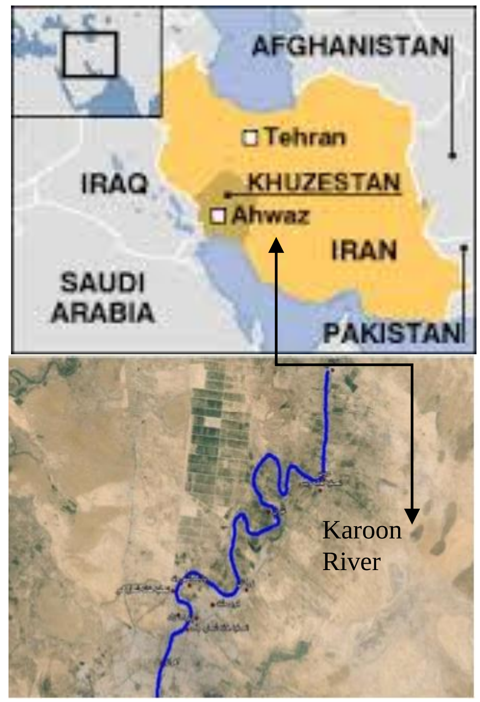

Fig. 1: The study area

1. *Data collection*

The data used in this study include cross-sections of the Karoon River from the Ghir Dam, upstream of Molasani, to the Kutabdollah region, 30 km downstream of Ahvaz, and the discharge-scale data from the Ahvaz and Molasani hydrometric stations. The HEC-RAS hydraulic model was used to determine the water surface elevations before and after dam localization.

2. *Rubber Dam*

A rubber dam is a thick rubber cylinder. Typically, such dams installed across rivers, and inflated with water or air. They serve as hydraulic barriers that maintain river water levels at the desired height.

3. *Rubber Dam Location*

Locating rubber dams requires detailed studies of the topography of the river bottom, and the flow hydraulics at all

water stages. The river bottom's longitudinal profile was considered to select different sites along the study area for evaluation for dam installation. In relation to the minimum depth of water upstream of the dam, the main purpose of constructing such dams is to create large lakes of sufficient depth for boating and recreational and water sport, so the minimum water depth behind the dam when the Karoon is at minimum discharge should never be less than 2 m. Two meters is the minimum acceptable safety condition for all kinds of recreational-sporting vessels and even water buses with capacities of up to 100 people can be used. However, dam construction on rivers is likely to cause the upstream water level to rise above dike level near the river, under flood conditions, which may cause problems. Hence it is necessary for the flood flow conditions to be simulated using different return periods. Dam location was determined on the basis of:

- The river's longitudinal profile
- The cross-sections developed along the river, both at the potential dam location and upstream of it
- upstream flow
- Geotechnical and geological conditions (as the dam material is rubber, this item is relatively unimportant)
- Availability of adequate space around the dam lake for recreation and tourism.

Results and discussion

Dam location and crest level determination

Locating the rubber dam depends on the river bottom topography, cross-section and flow hydraulics. The dam site is selected, therefore, on the basis of the river bottom's longitudinal profile, the river's width at the desired cross-sections, and the water level and depth, and river width upstream. Five sites were selected in different locations on this basis (Fig. 2).

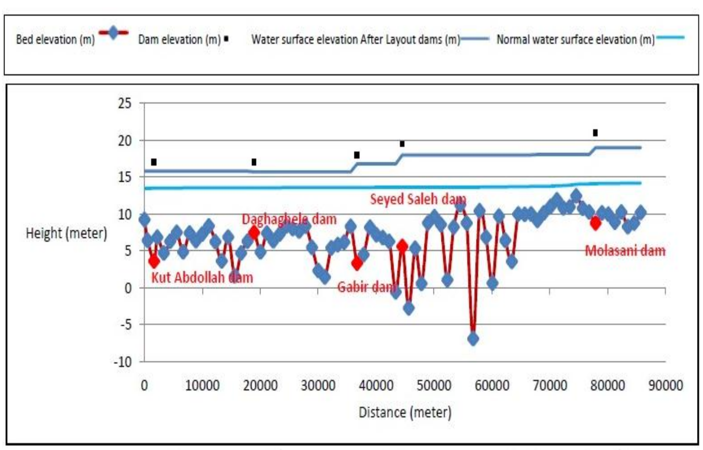

Fig. 2: Profile of the Karoon River bed, with water surface elevation and dam disposition

1. Molasani Dam

This dam is located at 24.298431E and 24.3494354N, near Molasani. The minimum water depth is about 2 m some 9,350 m upstream of it, close to Ghir Dam. The river slope in this section is gentle and, on the basis of Google Earth images, the average width of the river upstream of Molasani Dam is about 200 m. The rubber dam cross-section is about 115 m, and it can be installed by constructing insets. Crest height is 7 m above the concrete pad surface. Fig. 3 shows the river's cross-section at the dam site.

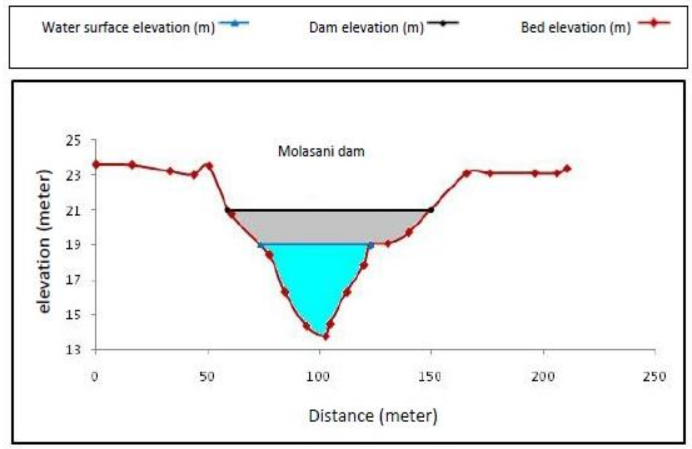

Fig. 3: Cross- section of the river at the Molasani Dam site

2. Seyed Saleh Dam

This dam is at 11.289251E and 97.3484456N, Its construction provides water to a minimum depth of about 2 m for about 26 km upstream. The river slope in this section is gentle and its reflux extends upstream to Molasani Dam. Google Earth images show that the average width of the river is about 180 m upstream. The dam cross-section is about 110 m and crest height is 5.7 m above the concrete pad surface. Fig. 4 shows the river cross-section at the site.

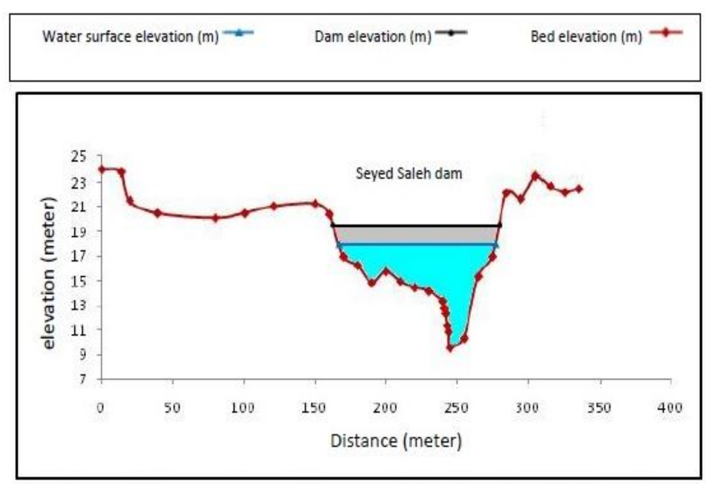

Fig.4: Cross- section of the river at the Seyed Saleh Dam site

3. Gabir Dam

The dam is at 29.287623E and 11.3481114N, near Gabir. Its construction yields a minimum water depth of about 2 m for about 12 km upstream. The river slope is gentle and the dam's reflux extends upstream to the Seyed Saleh Dam. Google Earth images show that the average width of the dam is about 170 m upstream and its cross-section is about 95 m. Areas with trees and green spaces are available, giving the possibility of creating playgrounds, sports spaces and water resorts. The dam crest is 6 m above the concrete pad surface. The river cross-section is shown in Fig. 5.

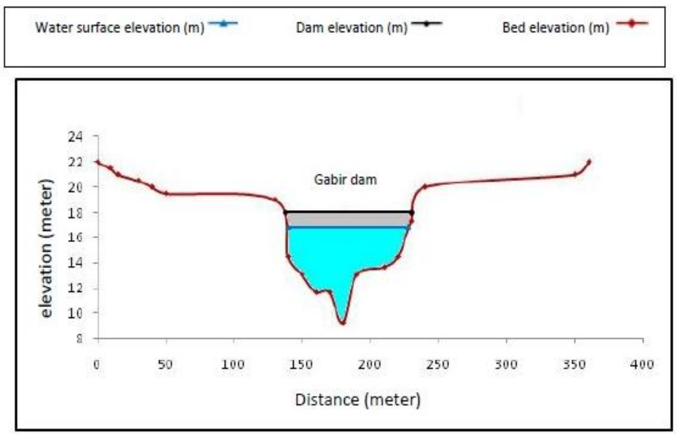

Fig. 5: River cross-section at the Gabir Dam site

4. Daghaghele Dam

This dam is at 93.279715E and 18.3473476N, near Daghaghele. Its construction provides a minimum water depth of about 2 m for around 18 km upstream, to Zargan. The river slope is gentle and the dam's reflux extends. As the drinking water supply for Ahvaz comes from Daghaghele pumping station, the dam location has been chosen so that it does not hinder the pumping station influent but does ensure smooth flow in times of low water. Google Earth images show that part of the river passes through a channel on the right before flowing into Ahvaz pumping station. The images also show that the average width of the dam is about 190 m upstream. The dam cross-section is about 100 m and the crest is 5 m above the concrete pad surface. The site is adjacent to Sharvand Park, so playgrounds, sports spaces and water resorts could be created. Figure 6 shows the river cross-section at the site.

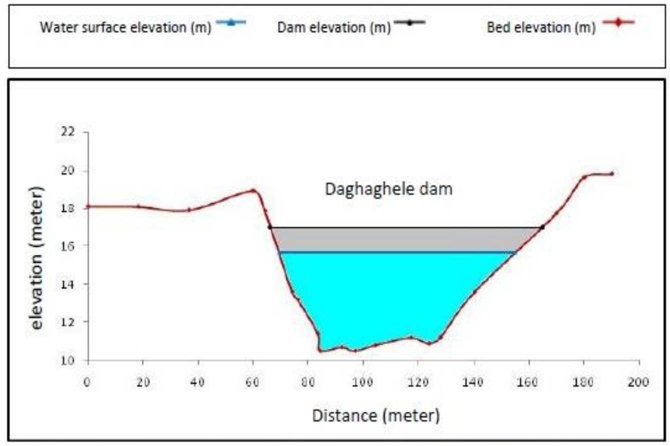

Fig. 6: Cross-section of the river at the Daghaghele Dam

5.Kut Abdollah Dam

The dam is at 28.274833E and 65/3458464N, near Kut Abdollah, upstream of the Jangiyeh curve. Installation provides a minimum water depth of about 2 m for 18 km upstream. Google Earth images show that the dam's average width is about 220 m upstream. The dam's cross-section is about 120 m and crest height is 8 m above the concrete pad surface. The river cross-section is shown in Figure 7.

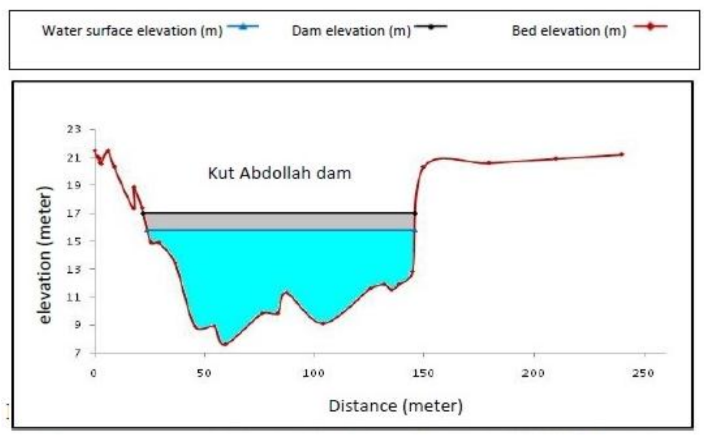

Fig.7: Cross-section of the river at the Kut Abdollah Dam

Tab.1: Characteristics of selected sites

Location	Width of river at site	Maximum river width upstream (m)	Dam elevation (m)	Water surface elevation (m)	Water level behind dam (m)	Average width of river upstream of dam (m)	Length of river affected upstream of dam (m)	Average volume stored upstream of dam (1,000 cubic meters)	Quality of access to dam
Molasani	115	290	21	19	2	200	9,350	3,740	Average
Seyed Saleh	110	300	19.5	18	1.5	180	2,6400	7,128	Average
Gabir	95	290	18	16.8	1.2	170	12,100	2,468.4	Good
Daghaghele	100	370	17	15.7	1.3	190	17,700	4,371.9	Excellent
Kut Abdollah	120	320	17	15.8	1.2	220	18,400	4,857.6	Good

Conclusions

The aim of the study was to investigate the possibility of installing recreational dams between Ahvaz and Molasani for water sports and recreational purposes. The dams' specifications, including locations and dam crest elevations, were determined on the basis of the hydrologic and hydraulic conditions in the Karoon River. Five separate locations were selected by these means. The characteristics of the sites, including – river width at the location and upstream, water depth upstream, dam site accessibility, and the volume of water stored and the length of the lake, are presented in Tab. 1.

As can be seen, the minimum river cross-section at any location is 95 m, at Gabir Dam, while the maximum width upstream is 290 m. and the depth of water which can be stored behind the dam is 2.1 m, the slope is gentle, and the average volume stored upstream reaches 5.2 million m^3. At Kut Abdollah the maximum river cross-section is 120 m, with a maximum upstream width of 320 m. Water can be stored behind the dam to a maximum depth of 2.1 m, and the average volume stored upstream reaches 85.4 million m^3. The cost of dam implementation is an important factor in construction, so it is necessary to choose sites with minimum cross-section and slope, and maximum river breadth upstream of the dam, along with significant storage capacity, to achieve the desired goals. Tab. 1 indicates that the best site for installing a rubber dam in the study area, is at Daghaghele Dam. The river's cross-section is 100 m, 3.1 m of water can be stored upstream, and the average stored volume upstream is about 4.4 million $m^{3.}$ The site has the further advantages that the surrounding area is covered with trees, an ideal environment for recreational purposes that decreases the additional costs of building gardens and parks.

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