

SECURITY ENHANCEMENT OF EMBANKMENT DAMS AGAINST TERRORISTIC ATTACKS, CASE STUDY OF ARDAK DAM – IRAN

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Keywords:

Embankment dam, Terrorism, Taliban, Ardak, Mashhad.

Abstract

Having geopolitical situation and lots of natural resources, Iran has experienced too many invasions throughout history.

In recent years, existence of Taliban in east and Salafi groups in West of Iran threatens the country by terroristic attacks and taking policies for confronting these attacks is of high importance.

On the other hand, the territory has a dry climate and water reservation is in agenda of the state. So dams -which some of them have been attacked- are strategic structures for the country. As a result, passive defense studies recognized as an inevitable part of dam constructing projects which costs too much.

The purpose of this article based on a passive defense study is representing some ways for confronting these terroristic attacks and reducing their following risks. For doing so, the Ardak embankment dam in Khorasan Razavi Province in east of Iran selected as case study. This is selected because its site of construction once was attacked by Taliban five years ago and will supply a major amount of Mashhad city -the capital of the province- water. First the region and threats which threatens it are explained. By supposing occurrence of any possible attack, damages due to these attacks assessed and ways of reducing their risks are reviewed. This includes the damages to the dam and its site as well as damages to down stream residential areas. Finally, a general method presented in order to use as a practical framework for similar cases.

Introduction

Iran as a developing country invests on strategic infrastructures like dams. In north - east of the country, where Razavi Khorasan Province is located, several dams are built or being built. On the other hand, area is near Afghanistan and existence of Taliban is a potential threat.

In this paper, impacts of two general kinds of terroristic attacks to Ardak embankment dam reviewed which is under construction. It will supply drinking water for Mashhad City. The site of Ardak dam was once attacked by Taliban forces. Maybe it happen again in future, so preventing solution is of high importance and government ought to take care of terrorism in strategic projects.

Attack to the dams is not a recent event but it happen for Dnjeprostoj dam in Russia (1941) and Mohne, Eder and Scorpe in Germany (1943). But nowadays it has new forms discussed in the paper.

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About The Region and Water Consumers

The dam located in 70 (km) of Mashhad city and 75 (km) of Iran – Afghanistan border (aerial distance).

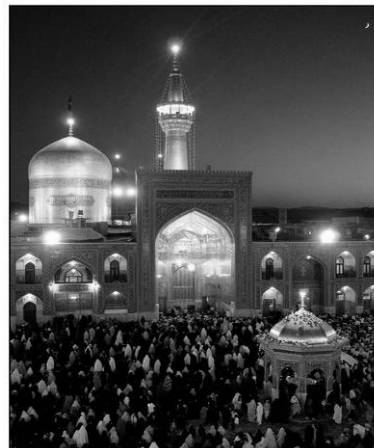
Mashhad

Mashhad is the second largest city in Iran. It is one of the holiest cities in the Shia world and of course holiest city in Iran. The city is located 850 kilometers (500 miles) east of Tehran, at the center of the Razavi Khorasan Province. Its population is 2,868,350 people (2006). Now Mashhad is notably known as the resting place of the Imam Reza (8th Imam of Shiites). A shrine was later built there to commemorate the Imam, which in turn gave rise to increasing demographical development. There are also over 20 million pilgrims who visit the city every year.

Figure 1: Mashhad



Figure 2: Imam Reza Holy Shrine



About Ardak Dam

In this part dam's purposes and technical characteristics is mentioned as basic information for predicting types of terroristic attacks and estimating following losses.

Purpose

Ardak dam is being constructed on the Ardak River. The dam will supply $18.45E6(m^3/year)$ of drinking water for Mashhad city and $11.33E6(m^3/year)$ of agricultural water for downstream lands.

Assuming the number of pilgrims, Drinking water consumption of Mashhad city is about $180E6(m^3/year)$. So Ardak dam supplies 10% of Mashhad drinking water.

Technical Characteristics

General Characteristics of Ardak dam is as follow (Table 1):

Table 1: Dam Characteristics

Type	Embankment dam - clay core
Height from river bed	61.5 m
Crest length	410 m
Crest width	10 m
Spillway	ogee
Free board	10 m

Source: Technical Report of Ardak dam

Site

Site of Ardak dam is located in mountainous region with intensive topography (Fig 3). Access ways to the dam are limited. Several floods reported during construction of the dam (Fig 4).

Figure 3: Topography of dam site



Figure 4: reported floods during construction of the dam



There is a holy place related to one of Imam Reza's descendants located 200 meters away of the dam site. Local pilgrims often visit the place.

Figure 5: Holy Shrine near the Dam Site



Terroristic Threats

Razavi Khorasan Province is in the neighborhood of Afghanistan. Since existence of Taliban in Afghanistan, They have been potential threat to Iran. Taliban do not believe in Shiites' Imams. This deep religious conflict causes many terroristic attacks on Shiites by Taliban. They kill Shiites as a religious duty.

On June 20, 1994, an explosion from a bomb occurred in a prayer hall of the shrine of the Imam Reza. The bomb that killed at least 25 people on June 20 in Mashhad exploded at Ashura. Mehdi Nahvi, a member of the People's Mujahedin of Iran (MKO), an Iraqi-based opposition group, claimed responsibility. The MKO stated that the bombing was carried out to commemorate the anniversary of the group's founding on June 20, 1981. Although government blamed the Mujahedin-e-Khalq in a TV show to avoid sectarian conflict between Shia and Sunni, the Pakistani daily "News" of March 27, 1995 reported, "Pakistani investigators have identified a 24-year-old religious fanatic Abdul Shakoor residing in Lyari in Karachi, as an important Pakistani associate of Ramzi Yousef. Abdul Shakoor had intimate

contacts with Ramzi Ahmed Yousef and was responsible for the June 20, 1994, massive bomb explosion at the shrine Imam Ali Reza in Mashhad."

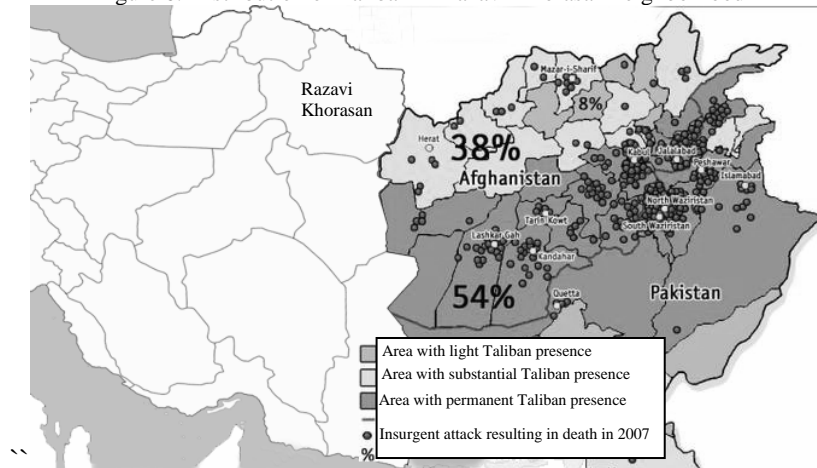
Mashhad has problem with Supplying drinking water for its residents, so the life in city would be more dependant on Ardak dam.

As a result, any terroristic attack to Ardak dam would cause several dangers to the city's residents as well as downstream area of the dam.

Situation becomes more dangerous by mentioning that Taliban once landed forces by helicopter at the dam site 5 years ago.

The probability of terroristic attack increases as there is a holy place related to one of Imam Reza's descendants located 200 meters away from the dam site. Local pilgrims often visit the place.

Figure 6: Distribution of Taliban in Razavi Khorasan neighborhood



Impacts of Terroristic Attacks

Two kinds of attacks can be supposed. In the first kind, the target is dam and its facilities. Exclusive materials are used in such attacks. Water contaminating by chemical and biological weapons is the purpose of attack in the other kind.

Damages due to first kind are discussed as follows:

Dam body

Generally, embankment dams are more vulnerable against military attacks in compare with concrete dams. In case of any damage to crest (crack in crest, core displacement, core cracking) this damage transfers to other parts of dam body. As a result, a weak cross-section occurs in dam body which lets water leakage through itself. Water leakage through these cracks and weak cross-sections widens the cracks. In this condition after few hours, the water pressure would destroy weak sections and finally whole the body would destroy. If an attack destroys the whole crest, this would lead to a more fast destruction.

Crest

In military attacks, crest is the most vulnerable part of dam, because it can have the greatest displacements and also is the thinnest part of the dam body. On the other hand, the material of dam body is of soil and it makes the crest more vulnerable.

Control room

After finalizing the construction of the dam it will have a control room. Control room is located on the crest near spillway. In case of any serious damage or being sabotaged, the security of the dam would be at risk.

Residential Camping

Set of residential buildings is located five kilometers away from the dam between mountains used as staff's residential camping. This area is between two mountains.

Physical Losses and Human Casualty

For estimating economical losses and human casualty in case of flood causing by dam break, three scenarios have been adopted. Water level in downstream rural areas has been determined via RiverCad and Hec-Ras Software for triple scenarios. Table shows assumptions for each scenario.

Table 1: Characteristics of Opening scenarios

Dam Opening	First Scenario	Second Scenario	Third Scenario
Height	80	100	80
Width	20	20	30

Discharge – time curves for triple scenarios are illustrated in Figures 7 to 9

Figure 7: Discharge- time curve for first Scenario

Scenario 1

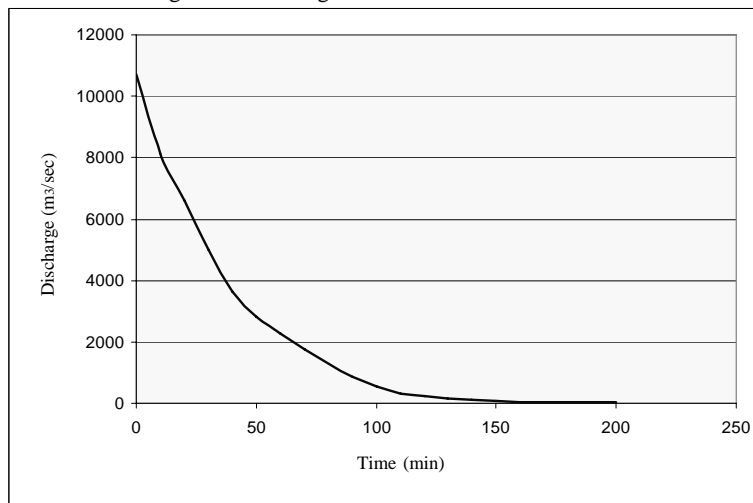


Figure 8: Discharge- time curve for second Scenario

Scenario 2

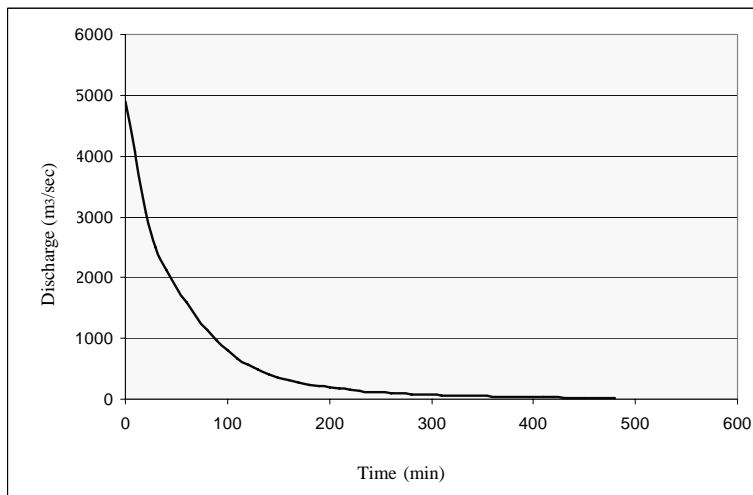
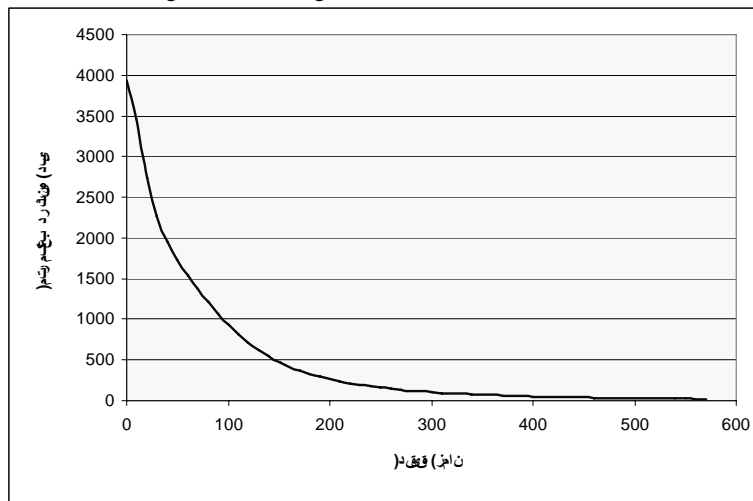


Figure 9: Discharge- time curve for third Scenario



Results of physical losses estimation are tabulated as follows:

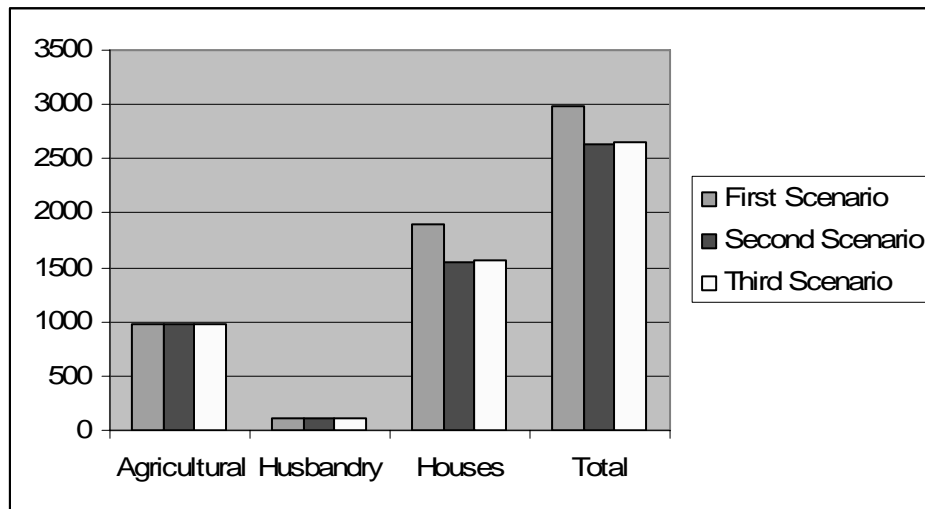
Table 2: Physical losses (1000 US dollar*)

	First Scenario	Second Scenario	Third Scenario
Agricultural	972	972	972
Husbandry	103	103	103
Houses	1904	1551	1573
Total	2979	2626	2647

(2008)*

In the following bar diagram the losses have been compared in three specific fields (agricultural, husbandry, house).

Figure 10: Comparative diagram of losses in three scenarios



Human Casualty due to dam break estimated for each scenario in the rural downstream lands (table 3).

Table 3: Human Casualty

First Scenario	Second Scenario	Third Scenario
1800	1500	1430

Human Casualty Due to Chemical and Biological Attacks

Ardak's water treatment plant can't sense chemical and biological contaminants. So if terrorists contaminate raw water by these materials, a terrible human disaster may happen in Mashhad.

However an exact estimation of casualties is impossible as it is dependant on type and amount of contaminant used materials.

Solutions

In order to reduce dangers to dam against terroristic attacks, some preventive and emergency solutions are suggested. They can be categorized in two levels:

1. Regional Level
 - Controlling access ways of the Province (preventive)
 - Planning for substitute resources of water for city (preventive)
 - Creating an IT system to inform security guard base in up or downstream areas (emergency)
 - Installing water quality sensing equipment for chemical and biological contaminants (preventive)
 - Determining a village as a rescue center (emergency)
 - Appropriate site selection for security guard basis (preventive)
2. Site Level
 - Fencing the area around the dam site (preventive)
 - Building watch tower around the dam site (preventive)
 - Building secret underground warehouses for vital facilities (emergency)
 - Training dam staff for acting in terroristic attack situation (emergency)

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Biography

Ehsan Malekipour is graduated student of Civil Engineering from Isfahan University of Technology and Student of MSc in Urban and Regional Planning in Shahid Beheshti University of Tehran. He is the chief of Naghshe Jahan International Institute of Sustainable Development. His thesis subject is Impact Analysis of Good Governance on Urban Sustainable Development.

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