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IMPLEMENTATION OF SEISMIC MONITORING FOR THE EAMPLE OF THE GISSARAK DAM

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Abstract

Implementation and analysis of comprehensive monitoring of the seismic situation of reservoirs on the territory of the Republic of Uzbekistan, in order to improve the quality of the obtained seismic data to study incoming seismic information about seismological processes in order to ensure the seismic safety of infrastructure facilities.

Introduction

The Gissarak reservoir is located in Central Uzbekistan on the territory of the Kashkadarya region. According to its structural position, this territory belongs to the region of transition from the Tien Shan epiplatform orogen to the Turanian platform. The seismicity of the territory is directly related to the tectonics of the region and manifests itself along the faults of the earth's crust, activated at the present stage of geological development. The areas of dynamic influence of active faults are combined according to the data of R.N. Ibragimov into seismogenic zones.[1]

Methodology and Instrumentation

Seismic monitoring at hydraulic structures. Today, the world has made great progress in the field of seismic monitoring of dams [2,3,4,5]. The high cost of seismic monitoring systems for large strategic dams, using available modern technologies for recording and transmitting data to remote control centers, is justified by the enormous value attached to these dams [6,7,8,9].

The data processing equipment supplied to the processing center included two servers equipped with advanced software for data collection, analysis and archiving. Data acquisition software is capable of automatically downloading data from remote locations upon startup and on demand. This software is also capable of remotely configuring, monitoring and synchronizing devices, as well as monitoring health status [10,11].

Seismic monitoring has provided seismology scientists with invaluable information about the structure's response to seismic activity based on time-lapse observations and early warnings. Using this information, facility personnel can perform rapid deployments and inspections to meet the need for safe and cost-effective operation of facilities [12,13,14].

One possible arrangement of instruments is shown in Fig. 1. This is given as an example only, but the actual number and arrangement can be made after a careful assessment of the needs depending on the type and importance of the dam and the seismic region in which it is located [15,16].

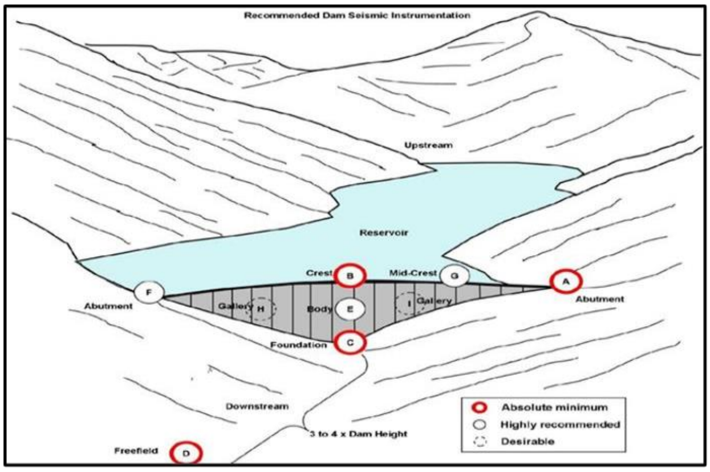

FIGURE 1. Layout of seismic instruments on the dam [15,16].

Since there is no Internet access or reliable land lines to transmit data from remote locations inside the dam and outside the two dams, the Global Mobile Telecommunications System (GSM) is used to transmit data in real time [17]. Mobile Telecommunications Systems are a proven technology for both temporary and permanent networked seismic telemetry communications (Fig. 2).

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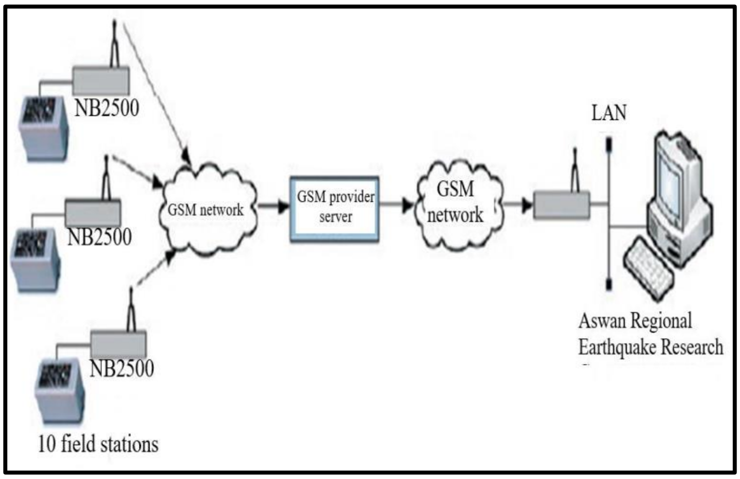

FIGURE 2. Seismic data transmission diagram [17].

Practice of using monitoring systems. The main goal of the entire project was the organization of a seismometric monitoring system for the main hydraulic structures and the organization of seismological monitoring of natural and man-made earthquakes on the territory of hydroelectric power stations and reservoirs. [18,19,20] (Fig. 3,4,5). In April 2022, firm «Geobitas», in accordance with Agreement No. 1 dated October 15, 2021, installed equipment for seismological observations at four reservoirs. The systems were installed on: Charvak, Gissarak, Andijan and Tupalang reservoirs.

Equipment required for seismic monitoring (Fig 3):

1) Solar panel
2) Charge controller
3) Battery
4) Digital seismometer «Appatit-V»
5) Media converter
6) GPS antenna
7) Chassis with media converters
8) Ethernet Switch
9) Personal computer
10) Protective box

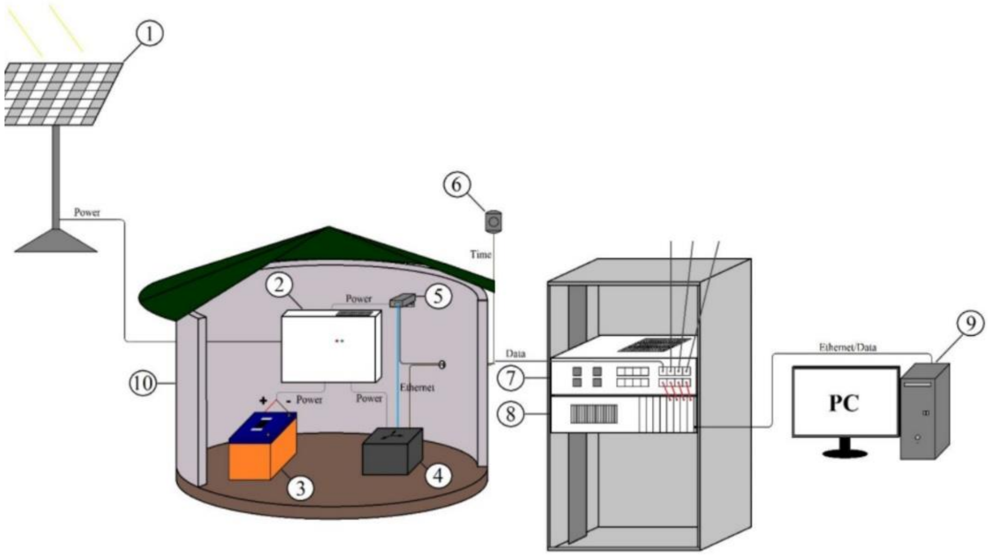

FIGURE 3. Seismological system diagram with a list of equipment.

The main objectives of the network are the continuous recording of data on ground movement at the locations of seismological stations and the transmission of recorded data on ground movement at observation points via communication channels to the data collection point.

A seismic monitoring system has been implemented at the Gissarak reservoir (Fig 4):

1) Solar panel-4 pcs
2) Charge controller-4 pcs
3) Battery pcs-4 pcs
4) Digital seismometer from «Appatit-V» -4 pcs
5) Media converter -4 pcs
6) GPS antenna -4 pcs
7) Chassis with media converters-4 pcs
8) Ethernet Switch -4 pcs
9) Personal computer -1 pcs
10) Protective box -4 pcs

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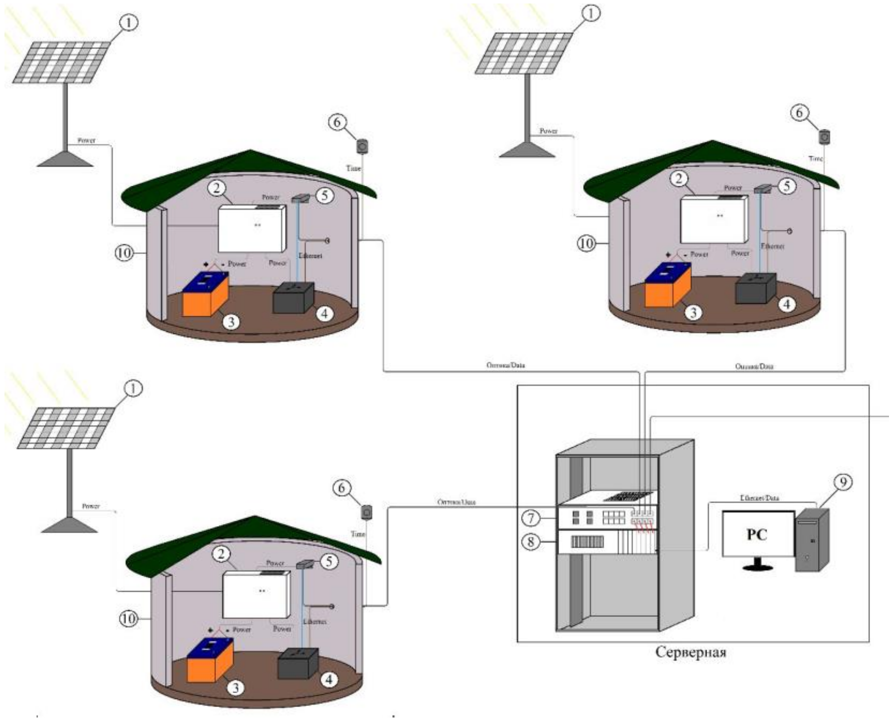

FIGURE 4. Schematic diagram of the seismological system.
General layout of seismometers at the Gissarak Dam (Fig. 5)

(a) (b)

FIGURE 5. Layout of the seismological system at the Gissarak dam (a), (b).

The seismological equipment installed on the reservoirs is a Russian broadband electromechanical velocimeter with a built-in MEMS accelerometer called «Apatit-V». (Fig. 6)

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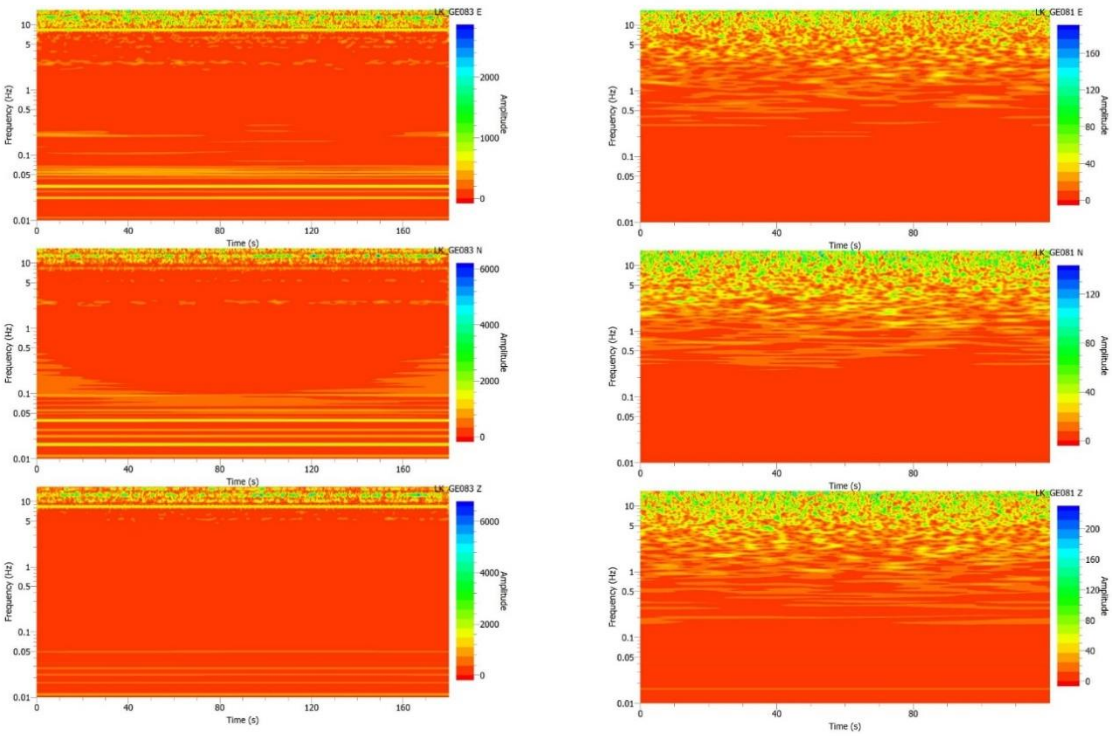
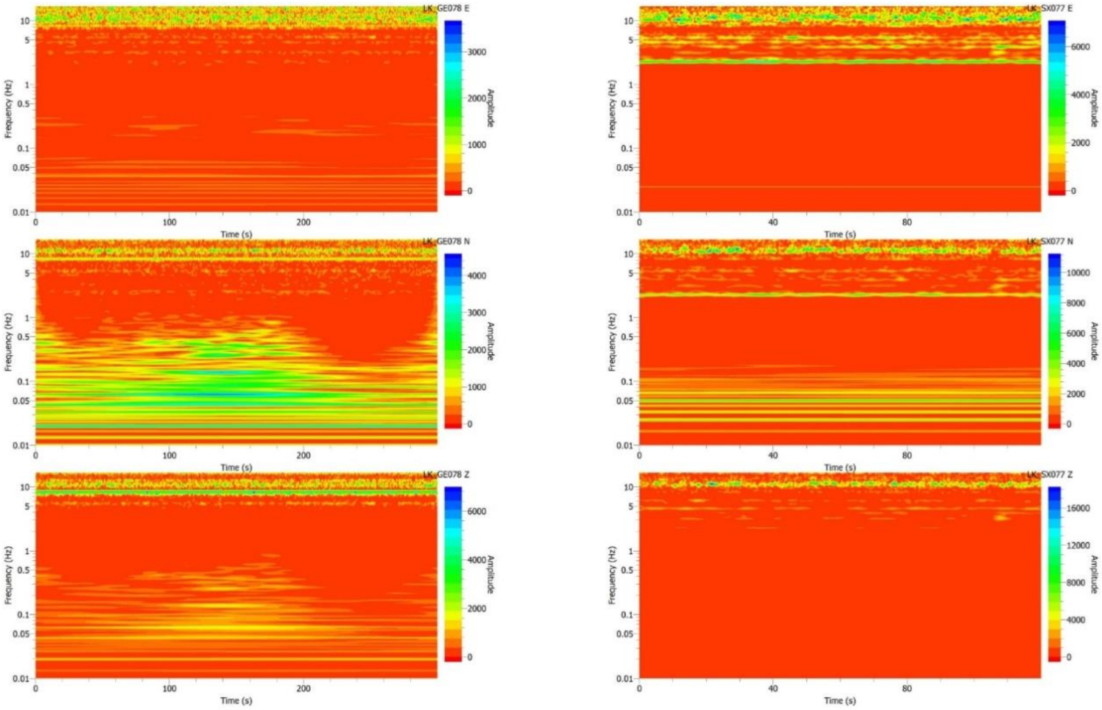
(a) (b)

FIGURE 6. Equipment layout and placement (a), (b).

View vibration spectra for 4 stations (low and high frequencies). Using the example of the Gissarak reservoir (Fig. 7)



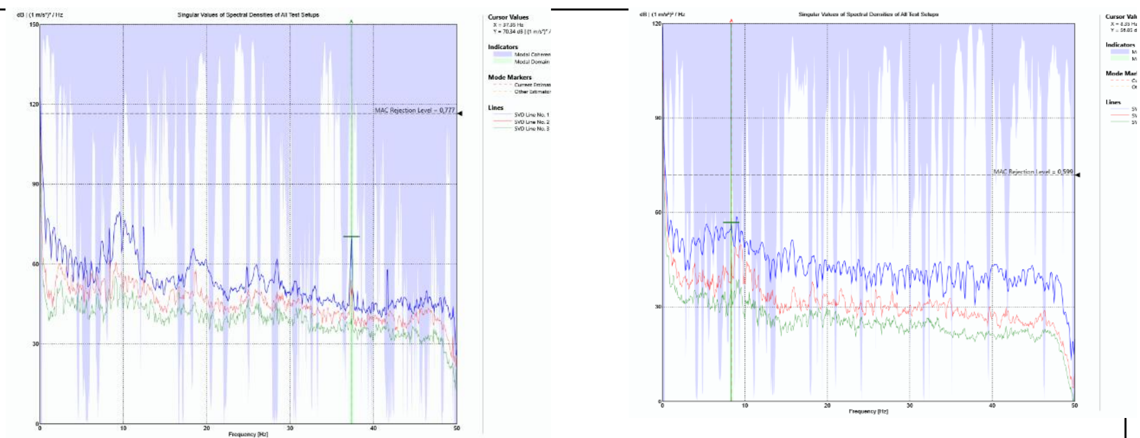
(a) (b)



(c) (d)

FIGURE 7. Results of vibration spectra data from 4 stations. Frequency =0.01-10 (Hz). Color amplitude=0-16000 (C) (a), (b), (c), (d).

The study used a damage detection module consisting of two different detection algorithms that were developed for long-term monitoring of structures (Fig. 8)



F(max)=37,3 Hz	F(max)=8,3 Hz

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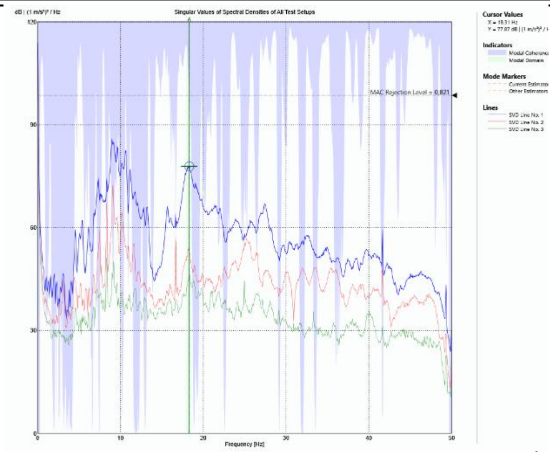	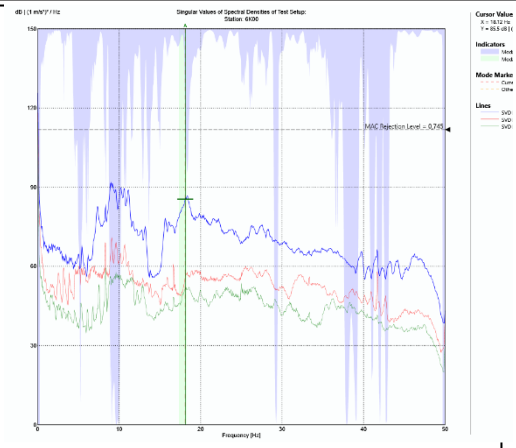
F(max)=18,3 Hz	F(max)=18,1 Hz

FIGURE 8. Resonant frequencies, judging by the analysis, range from F(max)=8.35-37.35 Hz.

Results

Seismic equipment of dams and reservoir sites is currently accepted not only for research work, but mainly for understanding the significant seismic hazards faced by existing dams in seismic areas. With the advent of digital seismic equipment, it can now be an integral part of dam safety monitoring efforts. Digital earthquake data can be collected by site personnel and remote-control centers using computers. When installing digital devices with a modem and communications, remote access is provided. Seismic instrument recordings taken from dam sites also help in the safe design of new dams in seismically active regions. Increasing awareness of the importance of seismic instruments for dams has led to their installation in large numbers at large hydroelectric facilities. Currently, there are many seismic equipment manufacturers available in the world. The degree of progress of firms in the production of seismometers, software development and data transmission. Seismic instruments are expensive to install, operate and maintain, but this clearly justifies their use in dams and makes their installation highly recommended.

CONCLUSION

Through seismic measurements and dynamic analysis of dams, it is possible to discover the reasons why earth and concrete dams consistently performed better than expected by design or analysis when shaken by earthquakes. These reasons may be:

—increasing damping, reducing the seismic impact on the dam;

—increasing the tensile strength of concrete under dynamic loading, which increases the elasticity of the object

— creation of a system that provides seismometric observations of the operation of a structure during the period of seismic activity;

— observations of the condition of the structure under seismic impacts are carried out to assess the possibility of the development of dangerous deformations and other signs;

—instrumental determination of the dynamic characteristics of the structure.

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