DAM SAFETY AND DEFORMATION MONITORING
(A STUDY ON OYMAPINAR DAM)

Halil Erkaya[1], R. Gürsel Hosbas[1], V. Engin Gulal[1], Nihat Ersoy[2], Uğur Doğan[2], Metin Soycan[1], Atınc Pirti[1],

YTÜ, Dept. of Geodesy and Photogrammetry Enginnering, Surveying Technnique[1]

YTÜ, Dept. of Geodesy and Photogrammetry Enginnering, Geodesy [2]

Keywords

Concrete arch dams, geodetic deformation observation, dam deformations

Abstract

Various constructions for control and effective use of water have been constructed since the beginning of the humanity. People have constructed the several engineering structure such as dams that one of the most important indicator for civilization as from 20. Century. The concrete arch dams have different importance among these structures. Also Oymapınar dam which is constructed on Manavgat stream in the north and 18 km far from Manavgat town of Antalya is a concrete arch dam.

Large dams are affected as continuously or periodically by several factors such as climatic temperature variations, water mass and strength, weight of structure, local and regional crustal displacement and the others. These effects called as deformation and cause the undesired variation on the structure. For many circumstances deformations do not disturbs statics of structure, but it cause undesired disaster occasionally. From this point of view, many measures can be taken by the help of deformation monitoring study.

The Oymapınar dam was completed 1983 as a hydro-electrical dam and it is operating today to produce electricity. To determine the deformations on the dam body, a geodetic control network with 6 reference and 25 object points was constructed before. The research group from YTÜ Geodesy and Photogrammetry Engineering was expanded this initial geodetic network with 7 new reference points between the periods 1985-1996.

Our research group is using same geodetic network for the 2007 and 2008 observation periods. In this paper, we focused on the processing strategy about 2007 and 2008 terrestrial and GPS observation.

1. Introduction

One of the most important parts of civilization is dams which constructed for several purposes. It is in the service of humanity about for 5000 years. Many dam ruins are found in old civilization such as China, Egypt and India. These civilizations have 60 percent of dams which placed all over the world. Turkey has 1% of these. Two old dams which inherited from Roman Empire are draw attention in Turkey. The first one is Örükkaya dam which was placed in the North and 190 kilometer far from Ankara. The other one was placed on Kocasu, in the South and 210 kilometer far from İstanbul Çavdarhisar.

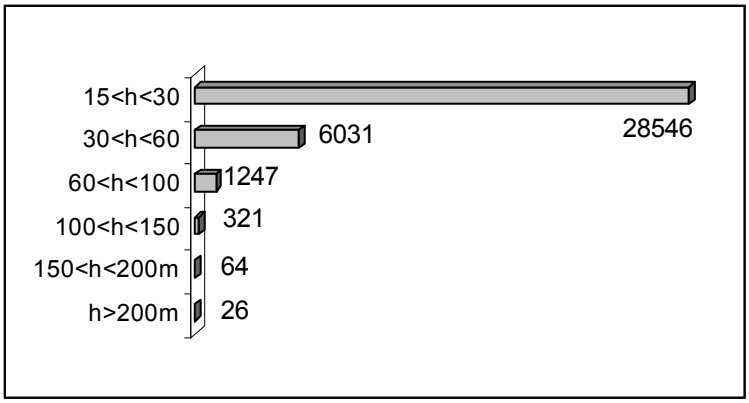
[1] YTÜ, Dept. of Geodesy and Photogrammetry Enginnering, Surveying Technnique, Turkey
[2] YTÜ, Dept. of Geodesy and Photogrammetry Enginnering, Geodesy, Turkey

In the beginning, dams were constructed for very limited purposes such as to protect flood and to supply drinking and irrigation waters. The population explosions with the technological and cultural developments required rising energy production after 1900's. Thus large and high dams considered and designed to product energy from huge rivers. The land roughness, personal faults, to remain limited areas for the construction of new dams with the other undesired reasons cause serious tragedy. Unfortunately, this kind of tragedies was results in very important damage in last years. From this point of view, it is very important responsibility to observe the structural geometry and to take measures (UZEL 1991;.GÜLAL, HOŞBAŞ 2001).

2. Some Statistical Information on the Dams

ICOLD (International Commission on Large Dams) was founded depends on The World Power Conference, in 1928 at Paris, then it has been performed several activity for the registration of dams where located several region on the world. The other important mission of the commission is the working about experience Exchange. According to ICOLD's records there were 36235 dams higher than 15 meter at the end of the 1986. The distribution of dams as to their height is given Table-1.

Table.1. The distribution of dams as to their height (ICOLD 1988)



As the results of the research performed by Australian scientist Dr. VOGEL whom founded DSSF (Data Station for Dams Failures) in 1980, there were 600 dam accidents between 1820 and1986. The reasons, number and their percentage values of 309 dam accidents are given Tablo-2.

Table.2. The reasons of dam accident (BLIND 1982)

Reasons	Number	%
Flood	111	35.92
Foundation problems	104	33.66
The displacemet of slope of hills	28	9.06
Construction faults	6	1.94
Cracks on the dam body	9	2.91
Wars	5	1.62
Computation errors	4	1.29
Earthquke	0	-
Other	42	13.59
Total	309	100.00

3. The Requirements of the Dam Measurements

Dam and the large engineering structures, etc., continuously or periodically according to the structure function of the temperature climate change, water mass and body weight, water power, traffic load and the moving of ground such as the various factors under the influence will remain. These factors negatively affect the structure and environment change in the structure to occur. These changes are generally referred to as the deformation. In most cases, this deformation of the structure and function of the static structure is a great danger, but can be turned into disasters occurring large deformation. Above many different factors under the influence of are arise from a structure to determine the causes of movements and to measure the "Control of measurement" is called (Figure1), (Gülal E., 2002 ve Dams4, 1999).

Figure 1. Taiwan Shih-Kang dam accident in a view (Dams4, 1999)

"Dams, etc. control structures should be why?" The answer to questions:

- Public safety responsibility,
- Dam safety work and to learn about the current situation,
- Determination of quality and quantity of changes in the dam,
- Acceptance of the theory and prove
- Account can be given as to develop methods and measures.

If an object;

- Static and structural value of the limit is reached; deformation and displacement are threatening the safety, for example: dams, bridges and towers.
- Geological and ground mechanics as inappropriate on the ground in a field or in the tunnel excavation work is done,
- Radio and television towers and chimneys of thermal power plants as they work in the large deformation of security is under threat

In this type of building is required to make periodic or continuous monitoring (Hoşbaş G. ve Gülal E., 2001).

These observations are divided into two parts for the control of dams with the quantity and quality of observations. Quantitatively with observations, especially to geodetic observations based on a scientific infrastructure, the building containing information about the status of the observations are realistic. Qualified observations, the structure of the negative behavior is determined by periodic visual checks are made (Gülal E., 2002).

To be done to measure the benefits of this control are:

• appear in Dam predetermine the potential dangers, damage measures can be taken to minimize.

• For parameters relating to the accounts Project the body of the assumptions or hypotheses which occurred at rates that can enhance the experience by seeing.

• Country conditions and 1 / 1 scale model derived from this fact the results can be developed according to the new body design. Moreover, the safety limit for a more realistic threshold to determine the cost of the construction of dams can affect positively (Algül, 1984b).

4. The Cause of the Dam Deficiencies

Dam statistics, the very soil of the dam filling, then the weight of the dam, rock fill dams and dams with one or more of the damage that they have curvature. Other than those of multi-arch type dam show fewer insufficiency can be said. Fill in the most dangerous dam the leak by increasing the development of internal erosion and as a result of water discharge on the face of downstream appear as a hole that is the case. This situation is called the pipe, the kernel on the back, which may occur because of insufficient remaining filters. Mostly as a result of the pipe, dam accident can develop quickly. Pipe evidence, filling sand tailings dams in the formation of the heel is downstream (Avella, 1993).

The most important issue is the formation of cracks in concrete dams. This cutting causes stress to the impairment. As a result, the structure can be put at risk the security. The causes of crack formation (ICOLD, 1988):

Heat of hydration results in a shrivel up or swell the resulting internal causes, such as alkali silicate composition, temperature change, the basic living and dynamic loading as a result of earthquakes and other causes may be in the form of the group(Avella, 1993).

The deficiency in Dam Square reasons; basic shortcomings, leakage, erosion, Wall movement, fluidity, disturbance of the concrete, lack of full sluiceway the lack of outlet, destruction, dislocation and can be sorted in the form of earthquakes.

5. The Geodetic Deformation Measurements of Oymapinar DamSections

Dam concrete arch dam in our country Oymapınar one of 7 that are on the next height of 150 m from the dam is one of 14. Seydişehir Aluminum Plant of the electrical energy requirements to meet the Manavgat River on the construction of the dam of the business opened in the process of sudden rise of water due to sluiceway full release of water of the dam by downstream the bridge left of the seaside feet slipped and Manavgat tea stone of the Manavgat district in the bazaar and tourist facilities waters remain under the led. A greater immediate danger and close to the Manavgat district of the ancient city of Side will cause loss of life and property should the idea of the dam to control the deformation of the continuous measurement of the eye requires making.

Control network between the first measure of 08.08.1983-07.03.1984 by the German company Bilfinger + Berger has been carried out in 17 periods. Then, Yildiz Technical University Geodesy and Photogrammetry Engineering Department consists of academic staff by the Research Group between the years 1985-2008 have been 19 periods of geodetic measurement. This measurement campaign in the spring of the last four to make the transition downstream plant in the middle of 2004 the number crest is added at the GPS network has been made to measure (Figure 3). On the network in 2007 for the promotion of the measure plan to the extent the general information is given in the table below.

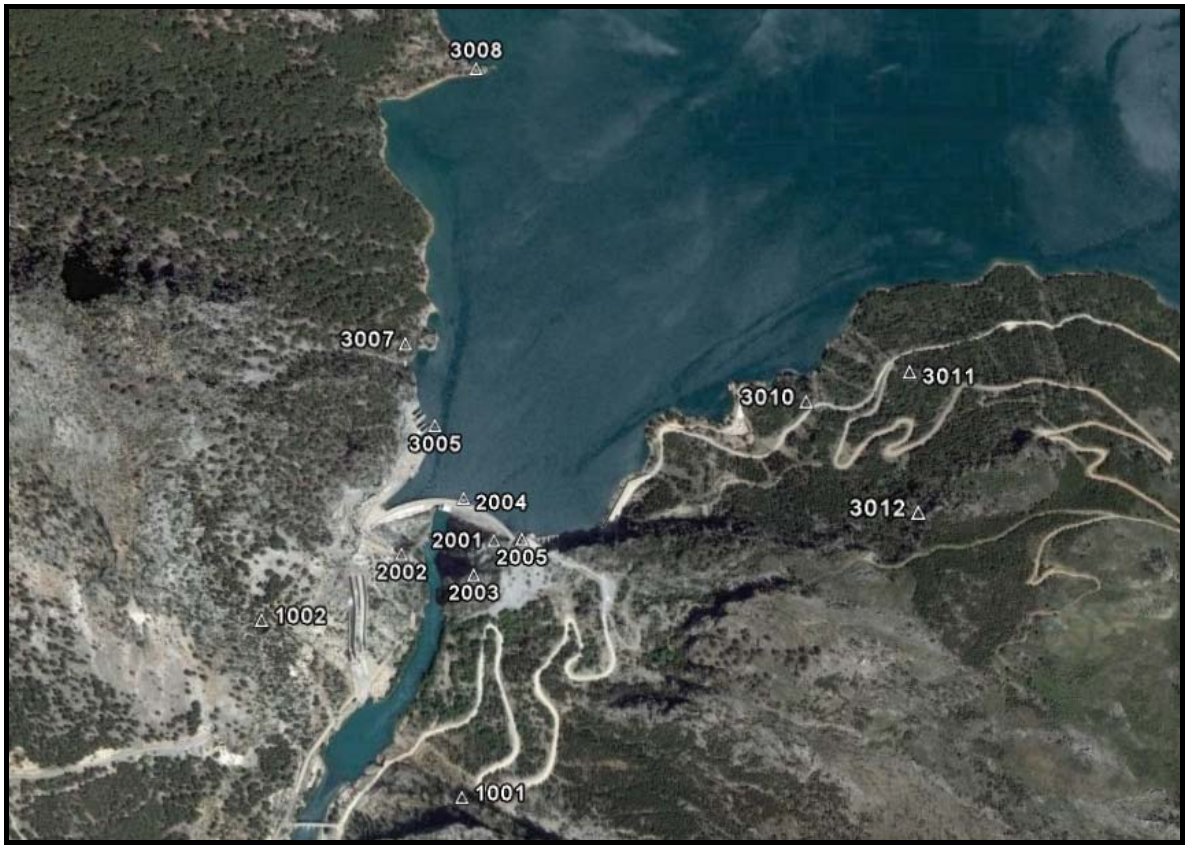


Figure 3. The geodetic control network in Dam Oymapınar

Table 1. The informations of the terrestrial and satellite surveys

The classification of survey	The number of observation	Information
Horizontal direction	136	11 reference point (3007 and 3008 except number of reference points)
Slope distance measurements	132	Reference point with reflective, non-reflective object point
The vertical angle measurement	132	Reference point reciprocal, Object point one-sided
Precise levelling measurements	40	2 Rs points and 19 levelling points on the crest
Some measurements of the components of basevector Dimensions	33	Except for the 1002 point between all the other reference points
GPS levellingGPS nivelmanı ölçüleri	20	2004 and 3005 the number of reference points with 19 levelling points on the crest

11 reference point 72 of the horizontal line between the extents of the observations. The measurement point on the subject line in 2001 at number 22, 2002 at number 22 and 2003 the number of observations at 20 to 64 is. Dimensions Leica TCRA 1201 (Serial No: 222716) and three full-range of the ATR system tachometer robotic electronic form has been made. Reference point and the horizontal direction, size, number of stations obtained from the experimental standard deviation for balanced information about Table 2, has been given.

Reference point between the curved edges of measuring instruments during the height of the point of clarification; see the point of the sign height is measured in mm accuracy.

Clarification on any point temperature, pressure and humidity were record. Three reference points to measure from the edge of the target markers on the subject point to the center were observed.

Vertical angle measurements were observed as well as three full-ranges in the horizontal direction in the form of measurement. Measures related to the number of reference points and measurements calculated from the experimental standard deviation for measurement information related to Table 3 'has been given.

Crest of dam body to determine vertical changes in precise geometric leveling in measuring the accuracy of measurement 0.3 mm / km as Leica DNA03 (Serial No: 336433) with digital precision level Leica GPCL2 (Serial No: 33309 and 34545) were used barcode invar staffs.

References

BLIND, H.:Sicherheit von Talsperren, Wasserwirtschaft Sayı 3 1982

ICOLD : World Register og Damms 1988

UZEL, T. : Barajların Güvenirliği , YTÜ Yayınları 1991

GÜLAL E., HOŞBAŞ G., "Barajların Güvenirliği", DSİ Teknik Bülteni, Sayı: 96, Sayfa:63-67 (2001).

HOŞBAŞ G., KARTAL F., ERSOY N., ERKÜÇÜK G., UZEL T., EREN K., GROTEN E., "Surveillance of Oymapınar Dam Deformations by means of geodetic control network" 1. Turkish International Symposium on Deformations. ISTANBUL 1994.