

Sensors

Are devices that are installed in dams for the purpose of observing the dam during operation and to evaluate in situ conditions for the dam and the surrounding areas:

1. Investigation stage and preliminary designs for the bridge: The devices are used to identify the nature of the bases, and cold, spring water monitoring and groundwater.
2. The implementation phase. Devices to measure movements Caldstovrat. Pore Pressure measuring devices.
3. Operating / hardware erected stage in his shoulders and the body of the dam and the surrounding areas the dam, to inspect movements that occur, changes the pressure and stress, colds.

Types of Sensors Depending on The Purpose of Monitoring Changes

Sensors to guide us to any risks affecting the stability of the dam, comparing reading zero with subsequent readings, and some devices where criteria specified by the designer, for example, any rise in piezometers levels gives indications of a malfunction. There are many types of sensors:

- Monitoring points
- Seepage Meters to measure the amount of seepage
- Piezometers the used to measure groundwater levels in the bases, under the foundations, and the surrounding facilities. They are attached to the dam usually concentrated in selected sections of the dam or expected malfunction in which areas.

Problems of Piezometers Readings:

1- Slow response piezometer / reasons:

- Blockage of the drill.
- Entry of sand from the upper nozzle tube because of the closed well.
- The position of the drill at low permeability clay layer.
- Piezometer away from the tank.
- Defect in the reading device

2- Fixed reading piezometer / reasons:

- Blockage in whole or in part of the drill pipe.
- Blockage of the main pipeline because of stones falling.
- Not change in the level of leaching and this phenomenon is good.

3- Dry piezometer:

- The piezometer on the wrong level or at impermeable layer.
- Clogged pipe because of large stone falling from the nozzle tube

4- Sudden change in the piezometric water level:

- This is important evidence of a change in the seepage paths.
- Piezometer filled with water after heavy rain especially if it has not closed its crater or that he has not placed under the correct specifications.
- Defect in the filters of dam, in many sites wet spots or green will appear downstream of the dam.
- Stop the pump of water from the drainages and flooded closed area.
- Defect in the reading device or pressure sensor.

- Trocar or dig a hole deep close to the site and this hole attracts seepage water and reduce attributed to rapid and substantial.

5- Piezometer influenced by acting work of extra grouting:

The moulder of grouting curtain means increased water seepage through which passers-by. This leads to a rise in the water level in the piezometers downstream and decrease in the levels of piezometers upstream. The efficiency of the grouting curtain depend on many factors, it causes the curtain of a difference in the water level in the piezometers downstream and upstream.

Pore Pressure Cells:

Water pressure that is generated in the foundations certainly affects the pressure of compacted soil. Pore pressure cells are placed at the intersection of the foundations points with compacted soil, it is buried in foundations of dam and end monitor the development of pore pressure during the execution of the dam and after the implementation of the dam, and be connected to wires out of the dam and its peak and readings recorded device go back to the tables recorded readings by device type and company.



Pore Pressure Cells

The pore pressure cells are very important for dam operating monitoring especially in the first storage stages. The reading of pore pressure cells can explain as following:

1. **Cell always read negative read:** usually produces an error in the calibration of the monument for the first time.
2. **Cell to stop reading suddenly and remains constant:** due to the sudden damage because of the cell pressure exceeds the design pressure or cut the wire carrier for any reason, or bad setup.
3. **Cell erected in the area of thick and impermeable layer.** This phenomenon may be a sign of quality clay core in the dam or that the implementation of the core of dam was very well led to prevent the seepage from this region.

Stress Meter

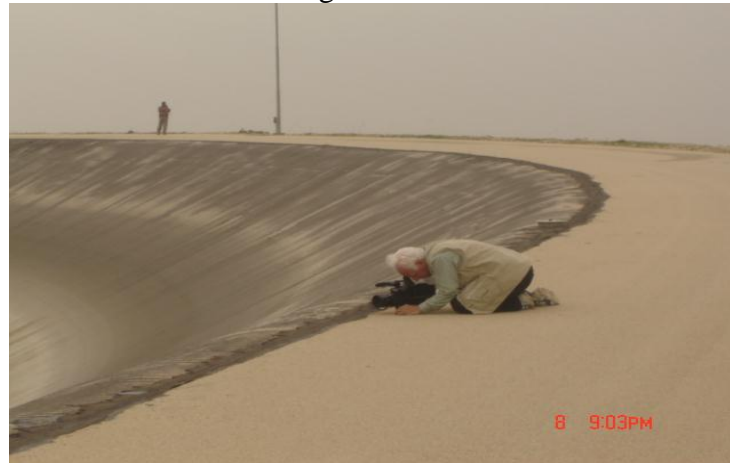
It is used to measure various stresses inflicted on earth fill and rocky foundations through the construction of the dam in the first years of operation. Common type of stress meter is known as distofor which usually is setup inside a pilot hole (borehole) to monitor any cracks in the foundation.

Seismic Monitoring Devices:

They are used for recording seismic events, which lies near the dam area. There are two types of these devices:

High sensitivity it is used to measure and record the exact events of seismic devices (micro seismic), which is possible to occur before the creation of the dam and the associated seismic events in the region. Then measure the possible seismic events occurring after the creation of the dam and spelled.

1. **Strong motion:** It is used to record events seismic strength of the medium and strong levels when they occur within the limits of the ground accelerating on-site. It is setup in different locations of the dam, at the crest, in the foundations, and in the outlet. It is integral system, record and sends the events that are recorded to a central recording station.



Seismic Monitoring Device Setup



Earthquake seismic structural monitors

Internal Deformation Meter:

To measure the internal landing slips in foundations (measuring device slips inclinometer).



Automatic multi-purpose dam deformation monitoring system

Joint Meter:

Measuring cracks in the joints of the concrete and other movements that occur.

Inverted Pendulum:

It is used for the purpose of measuring the deviation in the origin column to the right or to the left.