

Monitoring Dam Performance



- **Objectives:** Accurately measure structural stress
- **Solution:** Jewell Instruments Electrolytic 700 Series
- **Benefits:** High-precision and exceptional repeatability
- **Results:** Reliable and precise measurements

Overview

Jewell Instruments' 700-Series tiltmeters have been successfully used to continuously monitor deformations at the Ohau A, and Aviemore Power Stations and Waitaki Dam in New Zealand. With due care to installation details, they combine the sensitivity to detect small tilts ($<1 \mu\text{radian}$) together with superior long-term stability (drift $<\pm 10 \mu\text{radians/year}$).

Figure 1 shows the tilts detected since 1991 in the Ohau A Powerhouse pump gallery, where the

tiltmeter has been undisturbed since May 1994. Annual precise leveling surveys since 1989 have shown height changes along the length of the pump gallery (X Tilt direction) of $<2\text{mm}$ - illustrated in Figure 1 as height differences across the G4 block. The similarity of the tiltmeter and precise leveling results demonstrates the long-term stability for the tiltmeter, with a drift within $\pm 10 \mu\text{radians/year}$. The agreement between the methods also increases confidence in the tiltmeter should anomalous tilts be detected by the continuous monitoring between surveys.



Jewell Instruments 700 series tiltmeter

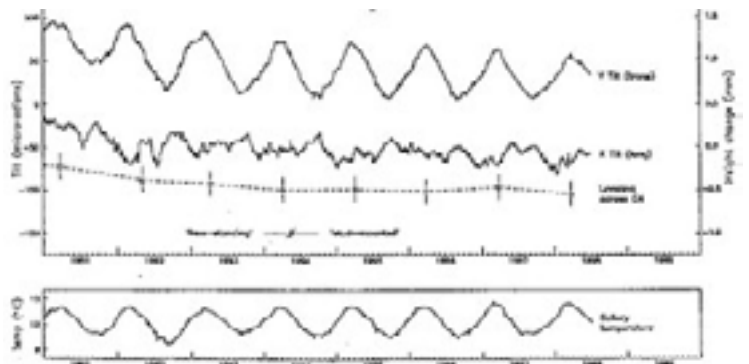


Figure 1 - Extracted from paper by M O'Reilly, S A L Read and P F Foster



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Figure 2 illustrates the tilts detected in the X Tilt (transverse) direction on the Waitaki Dam block 10. Annual thermal cycles are well defined, with the dam rotating upstream (i.e. negative tilt) with increasing air and lake temperatures. The greatest tilt variations are in the air gallery, where temperatures are very similar to those of Lake Waitaki, (shown in Fig.2).

Deformations associated with use of the overflow spillway in significant flood events are also apparent in Fig. 2. In December 1995 – the largest event monitored – tiltmeters in dam block 10 detected tilts up to 20 μ radians. These movements were equivalent to dam crest displacements of 0.5-1.0 mm.

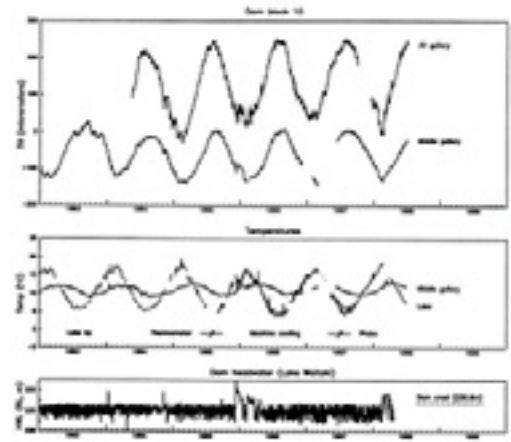


Figure 2



Dams Using Our Sensors

Hoover Dam - Colorado River, Arizona

Construction of a new visitors' center at the base of the dam required blasting of an elevator shaft within 4 meters of the dam's main penstocks. Jewell Instruments tiltmeters monitored the stability of the penstocks during blasting operations.

Coolidge Dam - Gila River, Arizona

Eight Jewell Instruments Model 800 Uniaxial Tiltmeters were installed in 1989-90 on the Coolidge Dam, Gila River, Arizona, to monitor possible dam movement. All tiltmeters are inside the dam, under the roadway and on the east-facing sides of the buttresses. An automated early warning system reads the tiltmeters to detect precursors to dam failure, then checks for false alarms and annunciates alert conditions.

Boundary Dam - Pend Oreille River, Washington

Boundary Dam in northeastern Washington, is a 340 ft. high, double-curvature, thin-arch concrete dam. Unique features include its thinness, pronounced overhang of the central cantilevers, relatively weak foundation zones, and cracks extending from the left abutment to the middle of the dam. In 1992, twenty Jewell Instruments biaxial tiltmeters were installed throughout the dam to continuously measure deformation 365 days per year. Data are recorded by an on-site datalogger and sent via telephone link to the owner's Seattle office.



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Dams Using Our Sensors Cont.

Russel Dam - Russel Lake, Washington

A 1,883 ft. concrete gravity structure flanked by rolled fill earthen embankments, Russell Dam crosses the Savannah River channel on a bedrock foundation. To determine whether foundation movement was occurring, Jewell Instruments tiltmeters were installed on the generator units following an elevation survey that established a benchmark for floor elevations. The system continuously monitored the angular position and point elevation of the two generator-support bridge beams in each unit.

Other Dam projects that used our tiltmeters:

Grand Coulee Dam, Columbia River, Washington Morrow Point Dam, Colorado River, Colorado Mactaquac Dam, St. Johns River, New Brunswick Municipal Water Supply Dam, Ironton, Ohio Loch Lomond Dam, Santa Cruz, California Leniham Dam, Los Gatos, California, Garvey Reservoir, Los Angeles, California



About Jewell Instruments

Jewell Instruments is a world leader in the design, manufacture, and distribution of high-precision products. Our expertise includes acceleration and tilt sensors, electronic compasses, avionics components, solenoids, and panel meters. The extensive application knowledge we have obtained through decades of experience allows us to provide custom solutions for a diverse group of industries. In fact, customers from all over the globe contact us for solutions to aerospace, medical, industrial, and telecommunications applications - to name a few.

To find out more, visit our website!



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